Chemical Library
FEB 1 1923

VOL. 8. DECEMBER, 1922 NO. 34

JOURNAL

OF

THE INSTITUTION

OF

PETROLEUM TECHNOLOGISTS

AND

RECORD OF TRANSACTIONS.

FOUNDED 1913—INCORPORATED 1914.

PUBLISHED BY
THE INSTITUTION OF PETROLEUM TECHNOLOGISTS,
5, JOHN STREET, ADELPHI, STRAND, LONDON, W.C. 2,
AND PRINTED BY
W. SPEAIGHT AND SONS, LTD.,
98–99 FETTER LANE, LONDON, E.C. 4.

PRICE 7s. 6d.

All rights of Publication or Translation are reserved.

W. J. FRASER & Co., Ltd.

ENGINEERS, DAGENHAM, ESSEX, ENGLAND

Complete Oil Distilling and Refining Plants Manufactured and Erected

ALL SIZES AND TYPES OF:

STILLS	AGITATORS
RETORTS	COOLERS
DEPHLEGMATORS	HEAT EXCHANGERS
CONDENSERS	TANKS, ETC.

CONSTRUCTED FOR ANY SPECIAL REQUIREMENTS

Send for Catalogue, Section 10, J. P. T.

Ltd.
LAND

Plants

ERS

MENTS

Co

Co

Ge

Pe

Ot

Th

Th

Re

Pr

Co

Ex

Ac

CONTENTS.

	PAGE
Council and Officers	i.–ii.
Committees	ii.–iii.
General Notices :—	
Copyright	v.
Issue of Journal	v.
Changes of Address	v.
To Authors of Papers	v.
Communications	vi.
Cases for Binding	vi.
Reprints of Papers	vi.
Medal for Student Members	vii.
Appointments Register	vii.
Library	viii.
Advertisements in the Journal	ix.
List of Advertisers	ix.
Personal Notes of Members and Special Notices ..	x.
Obituary Notices : Louis C. Sands and Thomas Hallowes Vaughan	xii., xiii.
The Standardisation of the Testing of Petroleum and its Products, by A. E. DUNSTAN, D.Sc. (Lond.), F.I.C., F.C.S.	578–617
The Galician-Canadian System of Pole-Tool Drilling, by ALBERT MILLAR, A.M.I.Mech.E.	617–665
Reviews	666–667
Polish and German Bibliography of the Galician Petroleum Industry, 1875-1922	668–700
Current Bibliography, compiled by W. J. WILSON, A.C.G.I., A.I.C.	701–799
Errata	714
Abstracts, compiled by Paul Dvorkowitz, Ph.D., H. MOORE, M.Sc., F. G. P. REMFRY, B.A., D.Sc., A.I.C., and T. A. SMITH, B.Sc., F.I.C.	800–806

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

NOTICES.

The Institution as a body is not responsible for the statements of opinions expressed in any of its publications.

Copyright. The entire contents of the Journal are covered by general copyright, and official permission is necessary for reprinting long abstracts; but editors may use not more than three pages of any paper, provided that credit is given as reproduced from the Journal of the Institution of Petroleum Technologists or advance-proofs thereof.

Issue of Journal. The Journal appears in four parts per sessional volume, viz., in January, April, July and October. A brochure describing the origin, progress and purposes of the Institution, and comprising also the Memorandum and Articles of Association, the By-Laws and Regulations of the Institution, the Library Catalogue to date (with subject index), and the List of Members, was published in September, 1915, to be followed periodically by revisions of the Library Catalogue and List of Members. The List of Members brought up to March, 1922, is now issued.

Members of all classes are entitled to receive these publications free; for additional copies of the Journal they will be charged at the price of seven shillings and sixpence per part, and of the brochures at the prices stated on the wrappers, varying in proportion to bulk.

Changes of Address. It is particularly requested that members notify the Secretary immediately of any change of address; and members are also requested to advise the Parcel Post Department, as well as the Letter Office, of any temporary change of address, as, unless this is done, parcel post packets will not be re-addressed, but will be returned to the offices of the Institution in London, thus incurring further expense for postage.

To Authors of Papers. Papers should be written in the third person and the copy should be carefully corrected by the author before it is presented.

All drawings, diagrams or other illustrations should be sent in a fit state for direct photographic reproduction.

All quotations, technical terms and localisms should be indicated by means of inverted commas.

Foreign weights, measures and costs should be given whenever possible, and also their English equivalents.

It is suggested that authors append as complete a bibliography of the subject treated as may be possible.

All papers and notes submitted to the Institution are supposed to be original communications unless distinctly stated to be otherwise, in which case the exact reference to the previous publication should be given.

Communications upon papers read at meetings, notices of personal movements, or other matter for which publication is desired in the next issue of the Journal, should be in the hands of the Editor on or before the last day of December, March, June or September, as the case may be. Subsequent delivery may be too late for insertion.

The Council desire to draw the attention of authors to the serious increase in the cost of production. Papers, both for the Journal and for communication to the Institution, should be as concise and condensed as possible.

Communications. The Council invite members to submit papers for the forthcoming session. Communications to the Institution will, subject to the approval of the Publication Committee, be published in the Journal.

Cases for Binding. Cases for binding the Journal can now be obtained from Messrs. Wm. Speaight & Sons, Ltd., 98, Fetter Lane, London, E.C. 4, at a cost of 1s. 6d. post free. Remittance to accompany order.

Members who desire to have their Journals bound in these cases should send their Journals to Messrs. Speaight & Sons, Ltd., with a remittance of 3s. per volume.

This notice applies also to all previous volumes.

Reprints of Papers. Contributors of papers to the Journal are entitled to 25 free reprints of their papers. Further 25 copies may be had on application to the printers at the following rates:—

2 pp. ..	2s. 0d.	12 pp. ..	7s. 6d.
4 pp. ..	3s. 0d.	16 pp. ..	10s. 0d.
8 pp. ..	5s. 0d.	20 pp. ..	12s. 6d.

* * *

Medal for Student Member. A medal and a prize of 5 guineas will be awarded annually by the Council to that Student Member of the Institution of Petroleum Technologists who shall in their opinion have presented a paper of outstanding merit during the year.

Appointments Register. A Register will be kept at the offices of the Institution for the convenience of firms requiring the services of members and for members requiring appointments, but on the distinct understanding that the Institution accepts no responsibility and gives no guarantee.

Fields Manager.

A large British Oil Company operating in the East expects to require the services of a Fields Manager within the next 6-7 months, and is prepared to consider applications from British subjects who have had lengthy experience in a similar capacity.

Applicants must be thoroughly conversant with all methods of drilling and production, and accustomed to handling American and other labour.

Preference will be given to applicants with Mechanical and Civil Engineering experience.

It is particularly requested that only candidates with the experience detailed above should apply.

Applications must be supported by full evidence of experience, also details of education, age, etc.

A man possessing the above qualifications might be taken on immediately in the position of understudy.

Apply FIELDS MANAGER,
Shaw & Blake, Ltd., Advertising Agents,
8, Bell Yard, Temple Bar, London, W.C. 2.

Library. The Institution's Library at No. 5 John Street, Adelphi, may be consulted between 11 and 4 daily. Extensive additions are being made to the current and standard literature on Petroleum.

Additions since publication of last Journal :—

Proceedings of the Institution of Automobile Engineers, 1921–22. Vol. XVI., Pt. II.

Stratigraphy of the Pennsylvanian Formations of North-Central Texas. By Fredk. B. Plummer and Raymond C. Moore.

From the Imperial Mineral Resources Bureau :—

Mineral Industry of the British Empire and Foreign Countries. War Period (1913–1919). Coal, Coke and By-Products, Part III. Nickel.

Iron Ore. (Summary of Information as to the Present and Prospective Iron-Ore Supplies of the World.) Part 6—Europe and Africa.

From the Department of the Interior, U.S. Geological Survey :—

Mineral Resources of the U.S., 1918. Part I.—Metals. By G. F. Loughlin.

Clay-Working Industries, Clay, and Silica-Brick in 1919–1920. By Jefferson Middleton.

Bauxite and Aluminium in 1921. By James M. Hill.

Tin in 1921. By Bernard Leroy Johnson.

Quicksilver in 1921. By F. L. Ransome. With a supplementary Bibliography by Isabel P. Evans.

Asphalt and Related Bitumens in 1921. By K. W. Cottrell.

Mica in 1921. By B. H. Stoddard.

Magnesite in 1921. By Chas. G. Yale.

Gypsum in 1921. By K. W. Cottrell.

Talc and Soapstone in 1921. By Edward Sampson.

Bulletin No. 730C. The Shape of Pebbles. By Chester K. Wentworth.

Bulletin No. 735E. Primary Native-Silver Ores near Wickenburg, Arizona, and their Bearing on the Genesis of the Silver Ores of Cobalt, Ontario. By E. S. Bastin.

Bulletin No. 736B. Oil and Gas Prospects in and near the Crow Indian Reservation, Montana. By W. T. Thom, Jr.

From the Department of Mines, Mines Branch, Canada :—

Summary Report, 1921. Parts A and D. Geological Survey.

Memoir 131. No. 112. Geological Series. Kenogami, Round, and Larder Lake Areas, Timiskaming District, Ontario. By H. C. Cooke.

No. 549. Report on Structural Materials along the St. Lawrence River, between Prescott, Ontario, and Lachine, Quebec. By Joseph Keele and L. Heber Cole.

No. 583. Talc and Soapstone in Canada. By Hugh S. Spence.

From the British Engineering Standards Association :—

Complete Sets of Publications and Specifications.

From the American Society for Testing Materials :—

Tentative Standards, 1922.

The attention of members is drawn to the new supplement of the Journal which deals with current Petroleum literature. To make this section of the maximum usefulness it is necessary that there should be full co-operation between chemists, engineers and geologists, and that matter which has inadvertently escaped notice shall be immediately sent to the Editor. The Institution is indebted to Mr. W. J. Wilson for the compilation of the bibliography.

Advertisements in the Journal. A limited number of Advertisements of firms interested in the Petroleum Industry may be inserted in the Journal. Application for terms, etc., should be made to Messrs. Commercial Publicity Service, 58, Warwick Street, Regent Street, London, W.1.

LIST OF ADVERTISERS.

(Members are desired, when making enquiries or placing orders with advertisers, to mention that they have seen their announcement in the Journal.)

ANGLO-AMERICAN OIL CO., LTD.
BAIRD & TATLOCK (LONDON), LTD.
BRITISH PETROLEUM CO., LTD.
CARR BROS., LTD.
CHAPMAN & HALL, LTD.
W. CHRISTIE & GREY, LTD.
A. T. CRAIG & CO., LTD.
DUNN MANUFACTURING CO.
W. J. FRASER & CO., LTD.
HAYWARD-TYLER & CO., LTD.
LUCEY MANUFACTURING CORPORATION.
THE NATIONAL SUPPLY CORPORATION.
OIL WELL SUPPLY CO.
VICKERS, LTD.
W. H. WILLCOX & CO., LTD.

PERSONAL NOTES OF MEMBERS AND SPECIAL NOTICES.

It is suggested that Members of the Institution send information regarding their movements to the Secretary for insertion under this heading.

Dr. W. HOPE HENDERSON, who was intimately connected with the Institution during its early days, has returned to England after an absence of several years.

Mr. B. F. N. MACRORIE left for Venezuela early in December.

Sir GEORGE BEILBY will be abroad until about March of next year.

Mr. ANDREW CAMPBELL is absent from England for about three months.

Mr. G. W. LEPPER is now in Burma.

Mr. WILLIAM SUTTON returned to England early in December.

Mr. A. J. GOODMAN has left for Burma.

Mr. C. A. PHILLIPS has returned to India.

Mr. G. W. TURNER is home for a short visit.

Mr. A. W. NASH is now at the Birmingham University as Lecturer.

Mr. C. W. WOOD has been transferred from the Government Laboratory, Cairo, to the Government Petroleum Refinery, Suez.

Dr. M. B. BLACKLER sailed for Persia early in December.

Mr. A. LLOYD EASTLAKE, who is in the London Division of the Royal Naval Volunteer Reserve, has recently taken a Naval Oil Fuel Course on board H.M.S. "Fisgard" at Portsmouth, and successfully passed both the theoretical and practical examinations.

Major R. W. BARNETT was returned as a Member of Parliament during the recent General Election.

It is with great regret that we learn of the death of Mrs. Robert Redwood, who passed away at Top Hill, Loughton, Essex, on December 17th, and we extend our sincerest sympathy to Mr. Robert Redwood in his great bereavement.

We have received from Messrs. Baird and Tatlock an illustrated catalogue of newly-designed apparatus for testing oils and petroleum. Electrical heating and ignition have been standardised throughout, and the range of testing plant includes viscometers, flashpoint, and fractional distillation apparatus.

CONGRÈS INTERNATIONAL DES COMBUSTIBLE LIQUIDES.

The Institution was officially represented at the Congrès International des Combustible Liquides, held in Paris, October 9 to 15, 1922, by Mr. G. W. E. Gibson and Dr. W. R. Ormandy.

H.M. PETROLEUM DEPARTMENT.

H.M. Petroleum Department has now been merged into the Board of Trade, and its offices are at Great George Street, Westminster, London, S.W. 1.

OBITUARY NOTICES.

LOUIS CLINTON SANDS.

It is with great regret that we have to record the death of Mr. Louis C. Sands, who passed away at his home in Pittsburg, U.S.A., on November 5, 1922.

Mr. Sands, who was sixty-four years of age, was born at Greenport, Long Island, and after finishing his schooling enlisted in the Navy. After completing his term of enlistment he spent a short time in a broker's office in New York, and then went to Pennsylvania, where he worked on the derrick floor. In 1885 or 1886 he first entered the services of the Oil Well Supply Company at Richburg, New York, and in 1887 was transferred to Lima, Ohio. In 1895 he entered the nitro-glycerine business, but after two years returned to the Oil Well Supply Company. Mr. Sands had charge of the Noblestown, Oakdale, and McDonald districts during their development, and in 1903 was elected Secretary to the Company. In 1908 he was elected Vice-President and General Manager, and that position he held until his death. He was also a Director of the American Petroleum Institute, the Diamond National Bank of Pittsburg, the National Union Fire Insurance Company, and the Presbyterian Hospital of Pittsburg.

During the Paris Exposition (Vincennes) of 1900 Mr. Sands superintended the drilling of an artesian well into the Lower Greensand at a depth of 1890 feet, and his activity in completing the well in three months, despite many difficulties, was commented upon by the leading men in the petroleum industry.

Mr. Sands last visited London in 1913, and although pressure of work has since confined him to the headquarters of his Company, he always took the keenest interest in oil developments in every land. His last literary work, the section on "Oilfield Development and Petroleum Production," in Dr. David T. Day's recent book, *The Handbook of the Petroleum Industry*, must have entailed an immense amount of labour in condensing the useful information contained therein.

A prominent figure in the petroleum industry, Mr. Sands was greatly respected by all who came in touch with him, his sympathy with British institutions and British people was well known, and his many friends and admirers in all parts of the world will deeply mourn his loss.

Mr. Sands is survived by his widow, one daughter, and his mother; and to them we tender our sincerest sympathy in their irreparable loss.

THOMAS HALLOWES VAUGHAN.

Mr. Thomas Hallowes Vaughan, who died on September 6 in California, was born in November, 1872, at Upton, Lincolnshire. He was engaged for several years on railway survey and construction work in the United States and Mexico, and in November, 1898, entered the services of Messrs. S. Pearson and Son, Ltd. He was employed on harbour-construction, water-supply, and drainage work in Mexico, and in May, 1910, was appointed Chief Construction Engineer. In October, 1914, he was made Technical Manager of the Mexican Eagle Oil Company, and held this position until February, 1916, when ill-health compelled him to resign. Whilst with this Company he had charge, among other duties, of the development of the pipe-line system in the early days of the Mexican oilfields, when the big gushers of that country were attracting so much attention in the oil world.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The Sixty-fifth Meeting of the Institution of Petroleum Technologists was held in the Rooms of the Chemical Society, Burlington House, Piccadilly, on Tuesday evening, October 10th, 1922, Prof. J. S. S. Brame, F.I.C., F.C.S., President, occupying the Chair.

The members of Council present were Sir Frederick W. Black, Mr. E. H. Cunningham Craig, Mr. Alexander Duckham, Dr. A. E. Dunstan, Mr. Arthur W. Eastlake, and Mr. Robert Redwood.

The President said the present was the opening meeting of the new Session, and it afforded him great pleasure to announce that the Institution was daily increasing in strength and numbers. On December 31st last, there were 276 Members, while there were 305 at the present time; and the corresponding figures for Associate Members were 125 and 140; for Students 55 and 66, and for Associates, 42 and 44. The total number of members, therefore, on December 31st, 1921, was 498, and at the present time 555, a very gratifying increase.

The Secretary read the following list of gentlemen who had recently been balloted for and elected as members of the Institution :—

Members.—Cecil Reginald Clark, Frederick James Tabor Frost, Arthur Hamilton, Edwin B. Hopkins, Constantin Osiceanu, James Smith, Rhesa Van Sickle, Marie Joseph Leon Wenger.

Transference from Associate Member.—Vincent Charles Illing, Cecil William Wood.

Transference from Student.—Hugh Peter William Giffard, Kenneth Watts.

Associate Members.—Francis Bawden Beringer, Ernest William Edwards, Daniel Alfred Hart, Herman Walter Merivale, William Ross McIntosh, John Trotter Storer, Edwin Thornton.

Transference from Student.—Ralph Peter Bolton, John Rickman Bourchier, Arthur Walter Cox, Raymond Harman, Samuel Raymond Prisk, George Sell, Norman Lillie Skilling.

Students.—Lewis Brace, Leslie William Marrison, Alfred Basil Miskin, Robert Gordon Bell Pringle, Stanley Battershill White, Edward Flasby Whittingdale, Henry Wellesley Wild.

Associates.—Loftus Kitchen Coughlan, Thomas Allen Paish, Edward Churton Powell.

The President said the paper that was to be read by Dr. Dunstan was on the "Standardisation of the Testing of Petroleum and its Products." The Council felt that it was very desirable that a summary of the work which had been carried on, largely in the late spring and during the summer months, by the various Sub-Committees which had been established to deal with the standardisation of petroleum products should be placed before the Members, with a view to eliciting from them any suggestions or criticisms they might be disposed to offer which would be of assistance to the Standardisation Committee, before its work was put into final form for publication.

The following paper was then read:—

"The Standardisation of the Testing of Petroleum and its Products."

By A. E. Dunstan, D.Sc. (Lond.), F.I.C., F.C.S. (Member).

The standardisation of the testing of a raw material, and of its manufactured products usually follows at some considerable distance from the commercial exploitation of these substances. A new industry has too much to occupy its attention at the outset, and its customers, potential and actual, are not as a rule hypercritical. Some industries never attain to standardisation, a glaring example being the coal trade, which even to-day sells its products on the most superficial description and without any guarantee of thermal value.

In certain cases standardisation of quality is compulsory by legal enactment, and a specialised technique of testing has been set up, to wit, for certain foodstuffs, and more recently for the heat value and purity of coal gas. Not often has an industry itself set to work to investigate and publish a system of accurate and dependable criteria for the benefit of its customers, and it must therefore be particularly gratifying to the Council of the Institution of Petroleum Technologists that its efforts, representative of the whole personnel of Petroleum, scientific, technical and commercial, should have received the co-operation of Government departments, and many widely spread organisations, far flung throughout the Empire.

A perusal of the names of the members of the Standardisation Committee, both internal and co-opted, will demonstrate the wholehearted effort which the Institution is making to bring this important matter to a sure conclusion.

Investigation of the files of the Journal will indicate that the question of Standardisation has occupied the attention of members from the inception of the Society. The first reference that occurs may be found in Vol. 4, 1917, p. 4, where Mr. A. Duckham (now President of the Standardisation Committee) wrote :—

"My suggestion is that the Institution should appoint a Standardisation Committee, whose reference should be to investigate methods of testing, and to recommend standards for adoption in this country. At present, in even the simplest tests, carried out on well-standardised apparatus, there will be found variations in results in the hands of different operators, this being due, of course, to small differences in manipulation, which have not been sufficiently detailed in the published instructions as to the conduct of the tests.

"I would draw your attention to such tests as melting-points, boiling-points, viscosities, both on account of differences in manipulation and of radical differences in the method adopted. Then, again, there are different methods of expressing results; for example, some laboratories will express their viscosity figures on a Redwood instrument in terms of the comparison with rape oil, whilst others give it in the number of seconds. Certain laboratories will report viscosities at 70° F., 140° F. and 200° F., others favouring 60° F., 100° F. and 212° F., and many other variations in these figures. In the determination of the cold test, of the asphaltic content, of the liability to emulsification, and in the estimation of aromatics, and so on, it is seldom found that the methods of any two laboratories are strictly comparable. I feel that in this short note I have dealt very inadequately with this most important subject, but I trust that what I have written will show what is in my mind, and that it may be considered of sufficient importance for the Council to decide to take action in the direction I venture to suggest. If such action were taken, I think it would be found advisable that the members of the Committee should be representative not only of the consulting chemist, but also of the works chemist."

The then President, Sir Charles Greenway, commenting on this proposal, said :—

"It did not greatly matter what method of testing was adopted, so long as the result shown was correct. What was wanted was uniformity of system, understood alike by producer and user—something equivalent to a universal decimal system. The question was one which should be taken up and settled at an early date, more particularly as there was now a disposition on the part of many countries to adopt a closer relationship, and find a common basis in all commercial matters."

Again, in 1920 the Admiralty Chemist (Arnold Philip, *Journ. Inst. Petr. Techn.*, 1920, 6, 7) said, *inter alia*:—

"In this connection it must be remarked that there are two policies which are advocated in the proposals which have hitherto been made for the standardisation of the conditions under which technical chemical testing is carried out. The first of these is to standardise the method of test upon the lines proposed for petroleum testing by Mr. Duckham. The second policy is to standardise the composition of certain representative samples of each kind of material by means of elaborate check-tests carried out by analysts of acknowledged standing, the method of test employed being left to the choice of the individual analyst. The standard representative samples of material whose composition has been fixed by these tests are then to be available for distribution to chemists for checking their own methods. This latter procedure is that which has been decided upon by the Iron and Steel Institute with reference to the chemical testing of iron and steel, and the necessary investigations are now in process of being carried out.

"A method of dealing with standardisation of chemical tests, which may perhaps be described as intermediate between the two above referred to, appears to have been decided upon by the conference held by the Institute of Chemistry on June 26th last, to consider the advisability of making provision for the preparation and issue of authoritative samples of chemical substances, metals, etc., of ascertained composition. This conference was attended by representatives of the Society of Chemical Industry, the Society of Public Analysts, the Institute of Metals, and the Federal Council for Pure and Applied Chemistry. The conclusions arrived at were that the provision of standard chemical substances was desirable, and that having regard to the fact that such standards could not be provided without reference to methods of analysis, the scheme should not aim at restricting the choice of methods, but always their revision and improvement.

"One objection to the standardisation of methods of test, as opposed to the preparation of samples of standard composition, by means of which samples each analyst can standardise his own method, is more serious than those referred to above, and consists in the real difficulty which is experienced in describing any method of test in such a way that different operators having different experience in testing will all apply it in the same manner. It is believed that most chemists who have had experience of the difficulties in testing on the large scale must have realised that, although a method of test used in a given laboratory may, as a

general rule, be carried out in the same manner, yet even under such conditions, with a large staff of analysts, the members of which change from time to time as resignations and fresh appointments take place, a good deal of careful supervision is required in order to secure that the routine of testing is carried out in all its necessary detail, even although full written instructions for the methods are supplied for information. Usually, these must be supplemented by direct verbal instruction."

In the discussion on Mr. Philip's paper other expressions of opinion were developed. Sir Thomas Holland pointed out that :—

"It was not only members of this Institution who would be affected by the proposal, but it would be necessary to work in concert with the chemical Societies and Institutions that had already done a considerable amount of work in that direction, and who were interested in one phase especially of chemical standardisation. There was also the question the President had alluded to, of International co-operation, which was one of great importance. The Institution need not postpone action until they had got all other countries into full co-operation, but it might be worth while to consider the desirability of bringing in the more important petroleum countries, especially America. It was desirable, therefore, that instead of acting independently in this country, they should obtain the enlightened experience of America, and move along lines of mutual advantage."

Professor Brame also touched on the importance of co-operation with other Societies and other countries :—

"This country was not producing petroleum in very large quantities at the present time, and therefore could not rank as a first-class oil producer, but there were many chemists and technologists in this country specifically interested in Companies producing largely in other parts of the world, and therefore the Institution should take its share in the question of standardisation. It was most important to remember that the United States had already gone a considerable distance in the matter, and some very excellent work had been carried out in the laboratories of the United States Bureau of Mines.

"The International Congress on Applied Chemistry had dealt with the two very important topics of standardisation of flash-point methods, and also with viscosities."

This year's Presidential Address was devoted to the subject of standardisation, and is too fresh in the memory of members to warrant quotation, but in brief, Professor Brame urged more particularly Anglo-American collaboration and gave a valuable summary of the work already achieved by the American Society of Testing Materials.

Work of the Standardisation Committee.

The main committee has appointed the following six sub-committees:—

Sub-Committee 1.—*Naturally Occurring Bituminous Substances.*—James Kewley, M.A., F.I.C., F.C.S., A. E. Dunstan, D.Sc., F.I.C., F.C.S., Chairmen; J. L. Jeffery, A.R.S.M., M.Inst.M.M., J. E. Hackford, B.Sc., F.I.C., F.C.S., W. J. Wilson, A.I.C., Robert Redwood, F.C.S., A. A. Ashworth, M.A., A.M.Inst.C.E., Peter Kerr, and F. B. Thole, D.Sc., F.I.C., F.C.S.

Sub-Committee 2.—*Distillates up to Kerosene.*—A. E. Dunstan, D.Sc., F.I.C., F.C.S. (Chairman), W. R. Ormandy, D.Sc., F.I.C., F.C.S., G. Rudorf, J. J. Fox, O.B.E., D.Sc., F.I.C., W. L. Baillie, S. E. Bowrey, B.Sc., W. J. Wilson, A.I.C., Peter Kerr, E. Lawson Lomax, M.Sc., F.C.S., H. T. Tizard, and A. G. Marshall.

Sub-Committee 3.—*Kerosene and Intermediates.*—Robert Redwood, F.C.S. (Chairman), Peter Kerr, W. J. Wilson, A.I.C., W. A. Woodrow, W. F. Higgins, F.Ph.S., A.R.C.S., and J. J. Fox, O.B.E., D.Sc., F.I.C.

Sub-Committee 4.—*Lubricants.*—F. B. Thole, D.Sc., F.I.C., F.C.S. (Chairman), S. E. Bowrey, B.Sc., W. F. Higgins, F.Ph.S., A.R.C.S., T. M. McKenzie, A.I.C., F.C.S., G. Rudorf, Ph.D., F. H. Garner, Ph.D., Eng. Captain W. M. Whayman, C.B.E., R.N., W. L. Baillie, Wm. Lee, and E. A. Evans, F.C.S.

Sub-Committee 5.—*Liquid Fuels.*—Professor J. S. S. Brame, F.I.C., F.C.S. (Chairman), Eng. Captain W. M. Whayman, C.B.E., R.N., F. H. Garner, Ph.D., W. J. Wilson, A.I.C., Arnold Philip, B.Sc., A.R.S.M., F.I.C., F.C.S., and W. A. Woodrow.

Sub-Committee 6.—*Asphaltum and Artificial Residues.*—J. E. Hackford, B.Sc., F.I.C., F.C.S. (Chairman), R. G. Batson, T. M. McKenzie, A.I.C., F.C.S., F. H. Garner, Ph.D., P. E. Spielmann, Ph.D., F.I.C., A.Inst. P., B.Sc., A.R.C.Sc.

TABLE OF SUB-COMMITTEE MEETINGS, MEMBERS AND AVERAGE ATTENDANCE.

Number of Sub-Committee	Number of Members.	Number of Meetings.	Average Attendance.
1	9	12	5
2	11	9	7
3	6	8	5
4	10	10	6
5	6	1†	6
6	5	12	3

† This Sub-Committee has operated by correspondence.

The respective chairmen of the various sub-committees have written short summaries discussing their activities up to the time of writing.

Grateful acknowledgment should be made here to the work of Mr. Banks, the Honorary Secretary of the Committee.

It will be noticed that many of the methods of the American Society for Testing Materials (A.S.T.M.) have been adopted. The references are attached. The suffix T refers to a tentative test. The figures at the end of the references relate to the year, *e.g.*, 21 represents 1921.

SUB-COMMITTEE NO. 1.—CRUDE OILS.

Tests and Decisions.

1. *Separation of Water.*—A.S.T.M. method agreed. D. 95–21T.
2. *Specific Gravity.*—Sp. Gr. bottle recommended. D. 70–20T.
3. *Flash Point.*—A.S.T.M. method agreed. D. 93–21T.
4. *Viscosity.*—Agreed to accept recommendation of Committee 4 of Redwood No. 1 to be used for viscosities up to 3600 secs., and Redwood No. 2 for values higher than 3600 secs.
5. *Cold Test.*—A.S.T.M. method agreed. D. 97–21T.
6. *Distillation Test.*—When only a small amount of material is available it was decided to recommend that the Engler distillation, as agreed by Sub-Committee 2, be adopted, altering the rate of distillation to 2–2½ c.c. per min. Distillation should be carried on till incipient cracking begins. A curve shall be plotted, showing the volume of distillate at various temperatures. For larger scale work the Committee recommend that at least 2 litres shall be distilled in a suitable metal still, fitted with steam pipe, and 6 in. Hempel column and condenser. It was regarded as impracticable to standardise such an apparatus, and only general instructions could be issued. The rate of distillation, for example, might be of the order of 1 gallon per hour per square foot of evaporation surface, and the ratio of steam should be so arranged as to minimise cracking of the oil. Refer D. 20–18T.
7. *Separation and Estimation of Water.*—A.S.T.M. method agreed. D. 95–21T.
8. *Ultimate Analysis for C, H, N, O, S.*—Carbon and hydrogen to be estimated in accordance with the usual technique of the organic chemist. Nitrogen by Kjeldahl method. Sulphur by the bomb. See A.S.T.M. D–22T for sulphur.
9. *Determination of Paraffin.*—Bureau of Mines method amended by using alcohol-ether in place of ethyl acetate.
10. *Determination of Asphalt: (a) Hard Asphalt; (b) Soft Asphalt.*—See recommendation of Sub-Committee 4 *re* Holde's method.
11. *Determination of Chemical Characteristics of Crude Oil.*—Deferred.

12. *Coking Value.*—A.S.T.M. modification of Conradson Test adopted. D. 47–21.

13. *Ash Content and Examination of Ash.*—Evaporate at least 1 litre of the oil to convenient bulk and ignite. Full qualitative analysis may be made in ash. It was noted, *e.g.*, that Mexican crudes contain vanadium and nickel.

14. *Examination of Adventitious Matter (B.S., etc.).*—It was decided to adopt the Bureau of Mines Method.

15. *Acidity.*—A.S.T.M. method agreed. D. 47–21.

16. *Saturated and Unsaturated Content.*—Deferred for further research.

17. *Free Sulphur.*—Extract with alcoholic KCN and test as usual.

SOLID AND SEMI-SOLID BITUMENS.

Tests and Decisions.

1. *Ultimate Analysis.*—As for crude oil.

2. *Ash Content.*—As for crude oil omitting preliminary distillation.

3. *Solubility.*—Await recommendations of Sub-Committee No. 6.

4. *Fixed carbon.*—Deleted.

5. *Acidity.*—Deferred until results of No. 5 Sub-Committee are available.

6. *Saponification Value.*—Deleted.

7. *Specific Gravity—Solid Bitumens.* Displacement method adopted.

8. *Penetration and Ductility.*—Await recommendation from Sub-Committee No. 6.

9. *Melting Point.*—A.S.T.M. method D. 36–21 adopted.

10. *Evaporation Loss.*—Under consideration by Sub-Committee No. 6.

11. *Flash Point.*—When necessary the Board of Trade procedure as for greases to be used, but the Pensky Martens to be used where necessary or desirable.

12. *Fire Test.*—Deferred until Sub-Committee No. 4 have come to a decision.

It will be noticed that several estimations of prime importance have been deferred, pending further investigation, and there is little doubt but that the Council will find it necessary to maintain a standing Standardisation Committee for the purposes of amending, supplementing and investigating.

Various Recommendations.

1. All Pensky Martens flash point apparatus to be standardised at the National Physical Laboratory.

2. All Redwood Instruments to be standardised at the National Physical Laboratory.

3. All Redwood Viscometers should be issued with a curve to convert readings into poises.

4. Standard temperature for specific gravity to be 60° F/60° F.

5. That the concentration of oil in solvent in asphalt determinations shall be one per cent.

6. Ethyl ether suggested as solvent instead of normal benzine in the estimation of wax.

SUB-COMMITTEE 2.

Distillates up to Kerosene.

A. SPECIFIC GRAVITY.

Specific Gravity may be defined as " The ratio of weights of equal volumes, at the same specified temperatures, of the liquid and distilled water."

Hydrometer.—Hydrometers should be standardised at the National Physical Laboratory or calibrated against a standardised hydrometer.

Temperature.—Works and routine tests should be carried out with a hydrometer standardised and used at 15.5° C. (60° F.).

B. COLOUR.

The colour of a Motor Spirit should be determined in any of the following forms of Colorimeter, viz., Saybolt, Stammer or Lovibond.

C. DISTILLATION.

Apparatus.—Standard Engler Flask.

The details of the apparatus recommended follow clearly those laid down by the A.S.T.M.

Procedure.—Flask to be clean and dry. Condenser to be rinsed with a little of the liquid under test and drained for three minutes, adapter being removed. 100 c.c. are measured in receiving cylinder which fulfils N.P.L. requirements and transferred to the flask, taking care not to wet the side arm. The same cylinder to be used for measuring the distillates. The cylinder mouth to be loosely covered with wet filter paper.

Preliminary period between starting the heating and appearance of first drop is to be a minimum of five minutes, and not to exceed ten minutes.*

The flame is to be set at a size to give desired rate of distillation, and suitably increased up to 90 per cent. off; then left at this size.

---

* For electrically heated apparatus reference should be made to the bulletin of the Bureau of Standards.

Initial Boiling Point to be first drop from side arm. Rate of distillation to be controlled by metronome up to 90 per cent. off, and to be 2 drops per second.

Rate of Distillation.—The rate of distillation, 1 or 2 drops per second, was discussed and the following tables compared :—

5 mg. Cotton 1½" hole in asbestos, 1 drop per second. (2-2½ c.c. per minute.)

I.B.P.	44°			
%	°	°	%	
10	90	75		
20	90·5	100	20·5	
30	107·5	125	53	
40	115	150	81·5	
50	122·5	175	95	
60	130			
70	139	Both series		
80	148	confirmed		
90	164	by repeat		
95	176			
Mist	189			
Max.	192			
Distillate			97·5	
In flask			1·5	
Loss			1	

5 mg. Cotton 1½" hole in asbestos 2 drops per second. (4-5 c.c. per minute.)

I.B.P.	44°			
%	°	°	%	
10	90	100	22	
20	98·5	125	57·5	
30	105·5	150	85	
40	113·5	175	96	
50	120·5			
60	127			
70	135			
80	145			
90	159			
95	172			
Mist	186			
Max.	188			
Distillate			98	
In flask			1	
Loss			1	

Arguments :

For 2 drops per sec. :—

(1) Test takes 20–25 mins. as against 40–45 mins.
(2) Higher percentage distillate at all temperatures.
(3) Lower final boiling-point.
(4) Brings test in line with U.S.A. standard test.

Against 2 drops per sec. :—

(1) Less effective fractionation than at 1 drop per sec.
(2) Burner flame needs more frequent adjustment.
(3) Operator must be more on *qui vive*.

Condensation equally effective at either speed.

It was suggested that the temperature when
1 c.c. } distillate are collected should be
2 c.c. } recorded as a guide to the easy
5 c.c. } starting property of the Spirit.

The results should be set out in the form of a graph.

D. Flash Point of White Spirit.

Abel instrument, in accordance with instructions of Board of Trade, to be used. The flashing temperature (close test) shall not be below 26·7° C. (80° F.), and not above 37·8° C. (100° F.).

E. Tests for Turpentine Substitutes.

White Spirit tests normally carried out are sp. gr., colour, distillation test and flash point.

20 c.c. of the material are shaken with 20 c.c. of neutral distilled water, and the acidity or alkalinity of the aqueous extract is determined by decinormal alkali or acid, as the case may be, methyl orange being used as an indicator.

When 0·1 c.c. of the material is allowed to fall upon a sheet of ashless white filter paper, and the paper allowed to remain freely exposed to the air at a temperature of about 15·5° C. (60° F.) for one hour, no "grease-spot" shall be observed.

One part by weight of fused calcium resinate (prepared from American resin) is dissolved in two parts by weight of the white spirit, and the resulting solution is exposed in the form of a thin film on glass in a vertical position. The state when dry to be observed as to greasiness and tackiness.

50 c.c. of the material shall be evaporated in a shallow silica dish (approximately 4 in. in diameter, and 1½ in. deep) on a boiling water bath for four hours, and the residue shall be weighed and inorganic matter determined.

Estimation of Benzene, Toluene and Xylene in Motor Spirit.

The method depends on the alteration of physical constants produced by removing the aromatic hydrocarbons from the solution under such conditions that no other bodies ordinarily present are attacked. Sulphuric acid of strength between 97 and 100 per cent. is the only reagent which safely effects this removal.

The two physical constants most suitable for measurement are specific gravity and critical solution temperature in aniline; each has its specific advantages. The former procedure is quicker in operation but necessitates an approximate knowledge of the specific gravity of the aromatic component; while eminently suitable when one aromatic greatly preponderates or when the relative proportions of the aromatics are approximately known it cannot so satisfactorily be applied to an unknown petrol for the determination of the total aromatics. The latter procedure is slower since a number of determinations are necessary, and, further, the aniline must be pure and freshly distilled; the linear portion of the curve from which alone calculations can be based only extends to about 20 per cent. of aromatics; beyond this stage a curve must be constructed from artificial mixtures of the petrol in question with aromatic hydrocarbons.

For estimation of total aromatics the critical solution temperature method is preferable; for individual aromatics either method is suitable. The two methods give concordant results, but neither is valid when the petrol contains olefinic ("cracked") components.

Specific Gravity Determination.

A 5 c.c. pycnometer is capable of giving results accurate to the fourth place of decimals. A tank thermostatically controlled is most convenient, but a beaker of water at about laboratory

temperature and a thermometer are adequate for infrequent tests. A density determination can be completed in five minutes.

C.S.T. in Aniline.

A test tube provided with a stirrer and thermometer is fixed in a wider tube as air-jacket and heated in a beaker of water. 5 c.c. of the spirit under test is placed in the tube, mixed with 3 c.c. of freshly distilled aniline run in from a 10 c.c. burette and the temperature of miscibility taken. Repeat experiments are made after successive additions of 0.5 c.c. of aniline till the maximum temperature at which complete miscibility just occurs is found.

Sulphonation.

Place in a 75 c.c. stoppered funnel about 20 c.c. of the spirit and 40 c.c. of sulphuric acid (between 98 and 100 per cent. H_2SO_4—this is important) and shake vigorously for 15 minutes; allow to separate, run off the acid and repeat the treatment with a fresh 20 c.c. of acid. Finally wash with caustic soda and water and dry with calcium chloride. Toluene and xylene are sulphonated with great rapidity; benzene dissolves more reluctantly.

Calculation.

(*a*) *Specific Gravity Method.* The specific gravities of benzene, toluene and xylene at 15·5° C. are 0·8841, 0·8712 and 0·8623 (appx.). Direct proportionality gives the approximate amount of aromatic hydrocarbon present, but to the percentage found must be added a small correction due to the slight expansion resulting when aromatic and non-aromatic hydrocarbons mix.

% Benzene calculated.	Correction to be added.	% Toluene calculated.	Correction to be added.
%	%	%	%
5	0·3	5	0·2
10	0·6	10	0·4
15	0·8	15	0·6
20	1·0	20	0·7
25	1·2	25	0·9
30	1·3	30	1·0

The results thus given are Vol./Vol. percentages.

(*b*) *C.S.T. Method.* The percentage wt./wt. of aromatics is given by multiplying the increase in C.S.T. after sulphonation by 1·15, 1·20 or 1·23 for benzene, toluene and xylene respectively. The average figure of 1.19 may be taken when the total aromatic content is being determined.

Estimation of Individual Aromatics.

It is impossible to separate completely fractions containing the individual aromatics, but considerable evidence is available to show that by one slow and careful distillation cutting at 95°, 122° and 150° C. the least overlapping admixture of aromatics is attained,

and, moreover, at these temperatures the extent of overlap in each direction most closely balances—*i.e.*, at 95° the amount of toluene which has passed over before this temperature approximately equals the amount of benzene which distils after 95° has passed. Distillation of 300 c.c. through an efficient column at a speed not exceeding 1 drop per second has given satisfactory results. The portion boiling below 40° C. may be rejected if desired; the "benzene" fraction is thereby rendered less liable to experimental difficulties due to excessive volatility; above 40° C. benzene begins to distil.

Determination of Benzene, Toluene and Xylene by the Tizard-Marshall Aniline Point Method.

Definition.—The aniline point of a hydrocarbon mixture is the temperature above which equal volumes of the hydrocarbon and pure aniline are miscible with each other. It is measured by pipetting 10 c.c. each of the benzine and aniline into a jacketted test tube fitted with a stirrer and thermometer dipping into the liquid. The mixture is warmed till the liquids give a clear solution, and is then allowed to cool, with stirring, till it becomes turbid. It is then re-warmed till it just clears again, and then allowed to cool. The temperature at which turbidity occurs is the aniline point. The second heating is necessary in accurate work to avoid the error due to lag of the thermometer in cooling rapidly from temperatures well above aniline point.

To determine aromatics, 30–40 c.c of the sample to be examined are "sulphonated" by agitation with three times their volume of 98-100 per cent. H_2SO_4 for half an hour. The product is separated from the H_2SO_4 and washed with NaOH and water. The washing can be dispensed with if no SO_2 is present after sulphonation. In this case the spirit can be pipetted direct from over the acid; but it is, of course, essential to avoid taking up any acid with the spirit. The difference of the aniline points of the sample, before and after sulphonation, gives the percentage of aromatics, in accordance with the following table:—

Increase of Aniline point on Sulphonation.	% Aromatics by weight. %
5° C.	5·9
10° C.	11·5
15° C.	16·8
20° C.	21·9
25° C.	26·7
30° C.	31·4
35° C.	35·9
40° C.	40·2
45° C.	44·3
50° C.	48·2

These data have been averaged from determinations of the lowering of aniline point by pure aromatics, using a wide variety of non-aromatic bases, and is correct to about 2 per cent. of the aromatic value. That is, a mixture which is found to contain 25 per cent. aromatics by this means may be taken as 25+0·5 per cent. If greater accuracy is required, the method of making up synthetic mixtures of pure aromatics and the "sulphonated" spirit may be used, as described in the paper by Tizard and Marshall.—(*J. Soc. Chem. Ind.*, 1921–20T.)

When unsaturated hydrocarbons are present a sample of the spirit is washed by thorough agitation with 80 per cent. H_2SO_4 (3 volumes for 30 minutes) and the aromatic content is given fairly accurately (if the degree of unsaturation is not too high—*i.e.*, if the iodine value is not greater than 50) by the difference of aniline points of the samples washed with 80 per cent. and 98 per cent. acid, respectively.

Determination of Individual Aromatics in a Motor Spirit.

Take 250 c.c. of the motor spirit and fractionate in an efficient fractionating column at the rate of 4-5 c.c. per minute. Change the receiver at 95° C., at 122° C. and at 150° C. Each of the three fractions, viz. :—

(A) Up to 95° C. (benzene fraction),
(B) 95°–122° C. (toluene „),
(C) 122°–150° C. (xylene „),

is now analysed for aromatics, as described in paragraph (1). The percentages of benzene, etc., in the fuel as a whole are calculated as in the following example :—

Total spirit taken	250 c.c.
Fraction (A)	70 c.c.
% Benzene in (A)	30%

Therefore % benzene in fuel as a whole $= \frac{30 \times 70}{250} = 8{\cdot}4$ per cent., and so on for fractions (B) and (C).

The total aromatics in the spirit should be determined independently, as a check.

It is more strictly accurate to work on a weight basis in the distillation, instead of volume; but the method outlined above is the more convenient for commercial use, and the error involved is not great. Thus, a spirit rich in aromatics gave the following results :—

	% in whole, working		
	By weight.		By volume.
Benzene	6·1	..	6·5
Toluene	16·3	..	16·2
Xylene	16·7	..	16·4
Total	39·1	..	39·1

The "cutting points" of 95° and 122° are of very general application for natural petrols, but do not apply accurately to a mixture containing a large preponderance of one aromatic. In this case, the correct cutting points may be specially determined.

The aniline used for these determinations should be freshly distilled, but is found to keep very well after distillation if stored over solid NaOH in a dark bottle.

Naphthenes.

The Naphthene content of the motor spirit is estimated from the aniline points of the fractions (A), (B) and (C) as obtained in the aromatic determination *after sulphonation*, as follows :—

Fraction (A)	Aniline point	70° C.	means	0%	Naphthenes.
	" "	60° C.	"	25%	"
	" "	50° C.	"	50%	"
	" "	40° C.	"	75%	"
	" "	30° C.	"	100%	"
Fraction (B)	" "	70° C.	"	0%	"
	" "	60° C.	"	33⅓%	"
	" "	50° C.	"	67%	"
	" "	40° C.	"	100%	"
Fraction (C)	" "	70° C.	"	0%	"
	" "	60° C.	"	50%	"
	" "	50° C.	"	100%	"

Each naphthene percentage is multiplied by the factor

$$\frac{\text{Volume of fraction}}{\text{total volume}} \times \frac{100 - A}{100}$$

(where A = aromatic content of fraction) to give the percentage in the total spirit taken, and the sum of these percentages is the total naphthene content of the fuel.

A very rough indication of the naphthene content can be obtained without distillation from the aniline point of the original sulphonated spirit by using the table for fraction (B) above.

If the fractionation for individual aromatics has not been carried out, the naphthenes are determined by fractionating the sulphonated spirit. In this case it is better to cut at 90° C. and 120° C.

The method for naphthenes is admittedly only an approximate one. It is based on experiments on some pure paraffins and naphthenes and mixtures of them, and receives considerable justification from the long series of special engine tests conducted by Mr. Ricardo.

A standard Dufton column is suggested for the fractionation, but any recognised column, provided that a rate of distillation of 5 c.c. per minute is not exceeded, may be employed.

G. Determination of Sulphur.

Recommended that the lamp method as described in the *J. Inst. Petr. Techn.* (1921, 1, p. 334), be adopted.

Where speed is an advantage the absorbent in the determination may be neutral H_2O_2, and the lamp may be replaced by a contact mass of platinum, over which the spirit vapour and air are passed. After boiling off CO_2 the residual H_2SO_4 may be titrated with alkali.

H. Qualitative Determination of Objectionable Sulphur.

(*a*) *Doctor Test.*

(*b*) *Copper Dish Test.*

It was suggested that, instead of a copper dish, a 2 × 1 cm. piece of electrolytic copper foil, cleaned with a boiling 10 per cent. solution of potassium cyanide, or a 10 per cent. solution of hydrochloric acid, and washed with ammonia, be placed in the Engler distillation flask and a note made of the percentage distilled when "blackening" occurs. This test should not be carried out in direct sunlight. The film should be dissolved off and tested for sulphur by the nitroprusside test.

J. Unsaturated Content.—The Committee considered that, at the moment, there is no accurate and satisfactory method of estimating the unsaturated content of a motor spirit. The iodine value is indecisive, whilst the absorption by varying strengths of sulphuric acid brings about more or less polymerisation. It was therefore decided to defer any recommendation on this subject.

It will be noticed that a few topics dealt with by the Sub-Committee have been discussed in some detail, notably the estimation of aromatic hydrocarbons, a matter which is of considerable importance, and one that has not yet found its way into any set of standard tests. In view of the necessity for increasing the capacity of motor fuel to withstand detonation, it has become the practice to incorporate "benzole" with those straight-run petroleum spirits which are devoid of naturally occurring aromatic hydrocarbons, and the Committee has therefore deemed it imperative to describe how these added and indigenous bodies may be estimated. It will further be noted that no method has been recommended for the determination of the unsaturated content of motor spirit. The valuable investigations of Brooks and Humphrey have indicated that the usual operation of absorbing these compounds in strong sulphuric acid is inaccurate and therefore, pending further research, no test is put forward.

SUB-COMMITTEE No. 3.—KEROSENE AND INTERMEDIATE OILS.

Specific Gravity.

The specific gravity is the weight of a volume of the kerosene at 60° F., as compared with that of an equal volume of water at

the same temperature, and any accurate method of determining the specific gravity is satisfactory for this purpose.

Hydrometers used for the purpose of controlling quantities should have a sufficiently open scale to allow of the specific gravity being taken to a fourth decimal figure (·0001).

FLASH POINT (CLOSE).

The flash point to be determined by the Abel apparatus, as defined by the Petroleum Acts, provided that the flash point is not above 120° F., and by the Pensky Martens Apparatus above that temperature.

The Abel Apparatus should not be used with water in the air jacket when testing oils flashing below 100° F.

The Pensky Martens Apparatus shall conform with the specification of the A.S.T.M., D. 93–21T, and the procedure used, should be as laid down in that schedule.

CALORIFIC VALUE.

To be determined by a Bomb Calorimeter in the recognised way

COLD TEST.

To be determined by the A.S.T.M. method (D. 97–21T).

KEROSENE.

DEFINITION.

Kerosene consists of those fractions of petroleum, distilling approximately between 150° C. and 300° C., which are applied as illuminants and as fuel for internal-combustion engines.

COLOUR.

To be taken by the Lovibond Tintometer with 18-inch cell, using the standard glasses of "Water White," "Superfine White," "Prime White" and "Standard White," with three intermediate glasses to divide the range between each pair of Standard glasses into four grades. It is recommended that the instrument should be used with artificial illumination, and that the question of the most suitable form of illumination should be referred to the N.P.L.

SULPHUR.

To be estimated by the complete combustion of a weighed portion of the oil with the subsequent determination of the sulphur in the products of combustion by any accurate method. The lamp method to be tentatively adopted.

DISTILLATION.

The apparatus and procedure to conform to the specification of the A.S.T.M. D. 86–21T., except that it is considered unnecessary to use ice to cool the condenser and that ordinary cold tap water would serve the purpose.

SIGNAL OIL BURNING TEST.

To be made by burning the oil in a signal lamp, fitted with a Welch Patent circular wick burner. The test to continue for seven days, the flame being adjusted to a height of seven-tenths of an inch after the oil has been burning for half-an-hour. The height of the flame and the weight of oil consumed should be taken every twenty-four hours.

MINERAL COLZA.

DEFINITION.

A well-refined illuminating oil of specially low volatility, and is used for Lighthouse purposes.

BURNING TEST.

To be made by burning the oil in a Trinity House Lamp.

GAS OIL.

VISCOSITY.

By the Redwood (No. 1) Viscometer.

DISTILLATION.

At least 300 c.c. to be distilled in a 500 c.c. Distillation Flask, with the top of the thermometer just below the outlet tube. The oil should be distilled at a uniform rate, so that the distillation takes at least 40 minutes, and the distillation stopped at 350° C. Each 10 per cent. fraction to be separately collected, the temperature of collection being recorded, and the specific gravity of the fractions and of the residue taken.

ASPHALT (HARD).

By the A.S.T.M. method, using Ethyl Ether, 100 volumes of the solvent to be used to 1 volume of the oil.

ASPHALT (SOFT).

By the Holde method, using 100 volumes of the solvent to 1 volume of the oil.

CARBON RESIDUE.

By the Conradson Apparatus, A.S.T.M., D. 47–21T.

SULPHUR.

To be determined by the Bomb method (tentative).

ASH.

To be determined by weighing the residue from the combustion of not less than one-third of a litre.

SUB-COMMITTEE No. 4.—LUBRICANTS.

Colour.—Lovibond Tintometer; ½-in. cell, or if occasion demands, ¼-in. or 2-in. cells. Glasses to be 500 series (yellow), and 200 series (red); blue (1180), if necessary. Method of illumination to be

considered later ; experiments are in hand with various "Artificial Daylight" glasses.

Appearance.—Reference to be made to fluorescence, turbidity and apparent nature of suspended matter.

Specific Gravity.—Adopt No. 2 sub-committee's recommendation.

Flash Point (closed).—Pensky Martens—A.S.T.M. specification.

Flash Point (open).—Under discussion.

Fire Test will follow automatically from decision *re* open flash test.

Setting Point.—A.S.T.M. procedure.

Viscosity.—Redwood No. 1. Standard temperatures, 70°, 100°, 140°, 200° and 250° F. Important details of procedure under discussion ; also certain possible improvements in design. Official conversion tables Redwood—Saybolt—Engler—Kinematic, should be published.

Volatility.—Though a test is needed, none at present merits recommendation.

Disruptive Strength.—B.E.S.A. procedure.

Demulsification Value.—A.S.T.M. method recommended tentatively. Further work is required as this method is not all that could be desired.

Ash.—100 gms. of oil burnt off in platinum dish.

Foreign Matter.—100 gms. of oil diluted with benzol and residue filtered, dried and weighed.

Colloidal Graphite.—Experimental investigations in hand.

Water.—A.S.T.M. D95–21T.

Asphalt (*hard*).—Procedure adopted at recent conference between Oil Companies and British Electrical and Allied Manufacturers Association, for analysis of Diesel Engine Fuel Oils—*i.e.*, precipitation with petroleum ether under detailed conditions.

Asphalt (*soft*).—Unnecessary.

Solid Paraffins.—No decision.

Tests for Greases.—Consideration postponed.

Coking Value.—No satisfactory test.

Oxidation (sludging test).—B.E.S.A. procedure.

Saponifiable matter.—Two methods of procedure are set out in detail : (*a*) A volumetric method (saponifying with standard alcoholic potash and titrating back) to be used when the nature of the fatty oil is known. (*b*) A gravimetric method, wherein the unsaponifiable oil and the fatty acids are isolated and weighed.

Acidity (inorganic).—100 gms. of oil are extracted with 100 gms. of warm water, and the latter separated, cooled and titrated. Results expressed as milligrams of potassium hydroxide to neutralise the water-soluble acidity of 100 gms. of oil.

Acidity (total).—25 gms. of oil are shaken with 100 c.c. of 95 per cent. alcohol, and titrated with $\frac{N}{10}$ KOH.

Acidity (organic).—Difference between total and inorganic acidity.

Sulphur.—Bomb method.

SUB-COMMITTEE NO. 5.—FUEL OILS.

The tests which this Committee has had to consider have been comparatively few in number, and in most cases the methods are well-known, and in everyday use in many laboratories, so that it became largely a question of deciding on particular patterns of apparatus, and laying down specific details for testing. Consequently, the work of the Committee has been carried on efficiently by correspondence, the Chairman circulating proposals for comment by members, and then circulating the summarised opinions of the members. In this way very fair agreement was arrived at, and only one meeting of the Committee has been held to go through any debatable points.

The tests and decisions were as follows :—

Specific Gravity.

As far as Fuel oils are concerned an accuracy of 0.001 was considered satisfactory, it being certainly within the limits of accuracy of calibration of tanks, etc. It was agreed (as suggested by Sub-Committee No. 2) to make the determination at 60° F., and refer to water at the same temperature.

With dark-coloured oils, the depth of immersion of a hydrometer being often difficult to read, it was decided to adhere to the usual method of calibrating, *i.e.*, for the plane surface of the fluid, and to establish the necessary meniscus correction for the different hydrometers.

Flash Point.

It was decided to adopt the Pensky Martens instrument, to the dimensions of the A.S.T.M.

The Chairman has procured measurements of some instruments, and has reported that whilst one firm's instruments are almost inside the tolerances of the A.S.T.M., some other makes are very wide of these. In general, whilst the instruments made by a firm are in good agreement as far as dimensions, they are generally widely different from another firm's, and the need for standardisation is greatly emphasised.

It was decided that the flash point should always be determined on the dry oil calcium chloride drying).

CALORIFIC VALUE.

The Bomb method was adopted. With regard to corrections, since the experience of some members was that results uncorrected for radiation, sulphuric acid and nitric acid formed, were in agreement within the limits of experimental error (say 0.5 per cent.) with the fully-corrected results, it was unnecessary to insist on full corrections (tentative).

It was also agreed to record the Gross Calorific value in B.Th.U. per lb.

SULPHUR.

The usual gravimetric estimation in the washings from the Bomb calorimeter was decided on, in agreement with the A.S.T.M..

ACIDITY.

There being no evidence that organic acidity was detrimental in Fuel Oils, it was decided to simply test for and estimate, if necessary, any acidity taken out by water, and to express the result in terms of milligrams of potash required to neutralise the water soluble acids in 100 grams of the oil, without any reference to any particular acid.

VISCOSITY.

Discussion took place on the relative merits of the Saybolt-Furol instrument and the Redwood instruments. Mr. Arnold Philip referred to extensive tests with the Saybolt instrument at the Admiralty Laboratory, which gave much greater variation than comparative tests with the Redwood viscometer. These results have been sent to the Chairman of the Main Committee.

It was decided to recommend the adoption of the Redwood instruments, No. 1, for the more fluid oils, No. 2 for the more viscous oils. No decision was arrived at for the limits within which the respective instruments should be used. As other Committees are concerned with viscosity discussion will be necessary with these.

Temperature of Testing.—No recommendation was made. Mr. Arnold Philip stated that the Admiralty specification for thick oils was at 60° F. in Redwood No. 2.

Expression of Results.—It was unanimously considered that there was no advantage in expressing results in terms of Absolute Viscosity, and that "seconds for outflow of 50 c.c. of oil" (specifying instrument) should be recommended.

WATER AND SEDIMENT.

Dr. Garner and Mr. Woodrow reported that their experience of the A.S.T.M. centrifuge method was satisfactory, especially when such quantities of water were present that difficulty arose with the distillation method.

After discussion it was decided to recommend the purchase from the funds allocated to the Standardisation Committee of a standard

set of A.S.T.M. Centrifuge Method Instruments, so that members of this and other Sub-Committees could carry out experiments. It was also suggested by Engineer Captain Whayman that the Admiralty would probably procure a set so that Mr. Arnold Philip could carry out experiments in the Admiralty Laboratory at Portsmouth.

In the meantime it was decided to recommend the A.S.T.M. Distillation Test (Dean and Stark's Method), but with the water collecting tube fitted with a tap, as recommended by Dr. Thole.

DIESEL ENGINE OILS.

CARBON RESIDUE.

It was decided to recommend the "Conradson Method" adopted by the A.S.T.M.

ASH.

It was decided to recommend the method of igniting a suitable quantity of the oil in a platinum dish.

ASPHALTUM.

After discussion it was decided to defer making any recommendation about this test, as at present there is no definite information as to the amount of Asphaltum permissible for oils for use in different makes of internal-combustion engines.

SUB-COMMITTEE No. 6.

The business of this Sub-Committee was to discuss and standardise the existing apparatus, and methods of testing petroleum bitumens for use as paving and road-making materials, and to devise new methods, if necessary. Seventeen tests in all have been considered, and these comprise :—

Specific Gravity.
Ductility.
Penetration.
Fixed Carbon.
Sulphur Content.
Melting Point.
Flash and Fire Test.
Loss on Heating.
Drop Test.
Solubility.
Ash.
Float Test.
Viscosity.
Water and Sediment.
Quantitative Determination of Bitumens.
Wax Content.
Determination of Tar, other than Petroleum Tars.

It is noteworthy that some of the apparently simple tests gave rise to the greatest discussion. The aid given by the National Physical Laboratory has been greatly appreciated, and agreement has been reached whereby different sizes of hydrometers have been standardised, as also have the sinkers, etc., appertaining to the Westphal balance.

In the case of some of the heavy tars which came under the notice of this Committee special means had to be devised in order to overcome temperature corrections and the difficulties attendant upon attempting to pour heavy oil into narrow-necked gravity bottles.

In order to render certain tars less viscous before taking the specific gravity on a Westphal balance, it is necessary to heat them in the first place. In order to maintain, more accurately, a constant temperature over the operation, the use of a Dewar cylinder has been recommended in place of the usual type of cylinder.

DUCTILITY.

While the usual type of machine has been adopted, it was found that various machines differed to some extent in dimensions. This question is being taken up with both Messrs. Dow and Smith, and also with English manufacturers. It was also considered advisable that tests should be taken at the English standard atmospheric temperature of 60° F. instead of the American temperature of 25° C.

SOLUBILITY.

The solubility of bitumens in various solvents has proved to be a very vexed question, particularly so in the interpretation of the results obtained. In many cases during the determination of "soft asphalt" it is found that ceresins and certain natural waxes are simultaneously precipitated, and the Committee are actively engaged in investigating this problem.

ASH.

The importance of the analysis of the ash has been emphasised as being of value in determining the origin (country of shipment) of the same.

VISCOSITY.

The importance of viscosity determinations has been also noted, and the question of the interpretation of the results discussed.

DETERMINATION OF TAR OTHER THAN PETROLEUM TARS.

A method has been discussed by means of which the percentage of coal tar products in a sample of paving bitumen can be determined.

The other tests have offered no outstanding features worthy of comment in this report.

TOLERANCE.

In the foregoing brief description of the activities of the various Sub-Committees, little has been said about the tolerances which should be allowed in the majority of the determinations. A tolerance should be provided for a variety of reasons :—

(1) To allow for the personal error of the operator.

(2) To allow for variation from standard in the apparatus used.

(3) To allow for conditions out of the control of the operator, *e.g.*, lighting, climate, etc.

As a case in point, consider the determination of specific gravity of benzine with the hydrometer (Sub-Committee 2). Personal error in reading graduation might amount to 0·0005 units. Variation from standard in this case would not arise if the hydrometer had been calibrated by the National Physical Laboratory, but the temperature correction might bring about another error, seeing that an omnibus correction of 0·0004 per degree Fahrenheit is usually employed for all and sundry gasolines. Consequently, it will be necessary to decide what tolerance is advisable. In purely visual tests the question of tolerance is complicated. For example, consider the copper test for corrosive sulphur in benzine. The operator has to judge whether a strip of copper is discoloured or not. It is obvious in such a case that personal opinion must enter and that it would be neccssary to provide each operator with a standard strip, which indicated the precise amount of discoloration that was permissible.

Again, in the use of colorimeters it is almost impossible to arrive at exact matching with a standard glass under different conditions of health and of lighting. In such an instance a wide tolerance must, of necessity, be permitted.

CONSULTATION WITH MANUFACTURERS OF SCIENTIFIC INSTRUMENTS.

A further and very important line of activity will be the providing of accurate data to manufacturers to assist the attainment of uniformity and the adoption of most convenient construction of standard forms of apparatus. Meetings will be arranged between the Standardisation Committee and the principal instrument-making firms for this purpose. Viscometers, flash point apparatus, distillation flasks, thermometers, hydrometers, colorimeters sulphur estimation apparatus and various special glassware will be considered. It appears reasonable to suggest that the National Physical Laboratory should be asked to co-operate—firstly, by storing a standard pattern, and secondly, by verifying models submitted to them, or supplying material of guaranteed constants for calibration purposes.

PUBLICATION OF BROCHURE.

Arrangements have been made whereby Professor Brame will edit a special brochure containing the recommended and tentative tests which have been decided upon by the Committee. It is hoped

that this brochure will appear early in the New Year, and it will, of course, be subject to periodical amendment, revision and supplement.

SAMPLING.

It will be noticed that none of the Sub-Committees has expressed an opinion of the correct method of taking samples. Mr. Arnold Philip in the paper to which already reference has been made has laid down some details of this very excellent procedure at the Admiralty laboratory. The Board of Trade Committee on Fuel Oil has also this matter under consideration, so that there is ample material in existence on which the Standardisation Committee can work.

DISCUSSION.

The President said the author had given a very lucid résumé of the work of the various Sub-Committees. The Council rather thrust upon Dr. Dunstan a very difficult task in asking him to undertake to prepare a summary of the work, and he was sure the Members would agree that an excellent description had been given of the work that had so far been accomplished. He did not propose to discuss the paper because he thought the discussion should come largely from other Members of the Institution than those who had been most active in carrying out the work. He only desired to say that there were two important bodies with which the Standardisation Committee had been associated, the first being the American Society for Testing Materials. The Standardisation Committee had, as the author had stated, adopted as far as possible the methods which the A.S.T.M. had accepted. He desired to say that a good deal of correspondence had taken place with their American brethren, and that they had been most cordial in every way in regard to the question of standardisation. The Institution's Standards Committee could not see eye to eye with them in every case ; they would, in some instances, raise points for discussion with them where they thought some modifications of the American methods would improve them, but they had every reason to hope that they would be met in that spirit of friendly co-operation which had been exhibited throughout. He also desired to say that the Institution had officially become associated with the A.S.T.M., *i.e.*, they had joined as a co-operative body. The Institution was now a Member of the A.S.T.M., and the Americans had paid the Institution the compliment of inviting it to nominate a Member to their Standardisation Committee, and the Chairman, Mr. Duckham, had accepted that position. He was sure it was the hope of the Members

that Mr. Duckham in person would be able at no very distant date to meet the Committee of the A.S.T.M., and in that way establish still further the cordial relations which had been set up. The other body to which he wished to refer was the British Engineering Standards Association, which was closely interested in many petroleum products. The Institution had been in touch with the Association, but he did not propose to deal with that matter because, fortunately, Mr. le Maistre, the Secretary of the Association, was present, and he proposed to ask him briefly to refer to the work of the Association in its relation to the question of the standardisation which the Institution had taken up. Standardisation of methods, and standardisation of specifications which would follow on standardisation of methods, would fall within the province of the two distinct bodies, *i.e.*, the Institution and the Association.

Mr. A. Duckham said that after what had been stated by the President and the author he had very little to say. He desired in the first place to correct the author's statement that he (Mr. Duckham) commanded him to read a paper. As a matter of fact, he implored Dr. Dunstan to do so, and when the author accepted the invitation it was much to his relief and tremendously to the benefit of the Members. The author had called attention to the fact that Sir Charles Greenway, when he referred to the matter in 1918, stated that it did not greatly matter what method of testing was adopted so long as the result shown was correct. The attitude taken up by the Committee was that they must not be too meticulous, and that what it was necessary to provide for the industry were really practical, comparable standards. The meticulous accuracy which some of the more scientific Members would like to see must be a secondary consideration. What was required was something by means of which one man could compare his work with that of another; "absolute" accuracy was not required, and indeed, would be impracticable in everyday work. The policy of the Sub-Committees, which had been very broad-minded, had been in the first instance to select the best that was available. They had been in no way parochial. They had sunk their own personal fancies. After selecting the methods which were available, certain gaps remained to be filled, and while some of those had already been made good, others could not be for some considerable time, as research work would be involved. For example, instruments were being obtained from America for the purpose of testing A.S.T.M. methods. From time to time as results were achieved, gaps would be filled and the standards published. He desired to impress upon the Members that there was nothing final about the work of the Committee; it would be modified and amplified as time went on, so that when the brochure was published it must

not be thought that a hard and fast and eternal standardisation was set up. The question of overlapping was referred to in the paper. A Sub-Committee formed its own individual opinion on any test, and Sub-Committees might and did form different opinions as to the best standard tests. This overlapping had largely been dealt with by consultation between overlapping Sub-Committees and it will be finally unified by the President. It would be noticed in the paper that the President would edit the brochure containing the recommended and tentative tests which had been decided upon by the Committee. He was sure the Members would appreciate how very important it was that when the brochure was published it should be uniform in style. It was hoped that the book would, in time, come to be found in every petroleum laboratory, and that it would be a very useful book of reference not only to the chemist, but to the student. The question of nomenclature had not been referred to. Names were of secondary importance at the moment, and were to be left until the more important question of tests was settled. He desired, in conclusion, to express his high appreciation of the remarkable way in which the various gentlemen who had taken up the work of standardisation had carried out their duties. He believed he was correct in saying that over 100 out of 135 tests scheduled had been standardised within the year. That was a wonderful piece of work for which the greatest credit was due to those concerned. He also desired to express his appreciation of the excellent services rendered by Mr. Banks, the Honorary Secretary, to the Standardisation Committee.

Mr. C. Le Maistre, C.B.E. (Secretary of the British Engineering Standards Association) said he was not qualified to discuss the details of the paper, but was most interested to see that the work which had been initiated through the efforts of Mr. Alexander Duckham was being carried to such a successful conclusion. In so far as the British Engineering Standards Association was concerned he felt the work of the Institution Standardising Committee would be invaluable to them when dealing with the question of fuel and lubricating oils for engineering purposes, which, with the co-operation of the Institution, they were about to take up. He believed that in collaboration with the Institution they were undertaking a very big task. He did not desire to give a long history of the B.E.S.A., beyond saying that it was an entirely independent neutral body, representing every branch of industry in the country which could be included under engineering and the allied trades, and recently chemical engineering. The Association was constituted originally by the chief technical societies of the country. It consisted of a Main or Executive Committee and a number of Sectional Committees and working Sub-Committees. Each of the Sectional

Committees represented a particular branch of industry, and once formed, was autonomous and governed the whole of the work under its control. Reference had been made to the question of the tests and the procedure to be adopted so far as the organisation of the Association was concerned. He thought the procedure was quite clear. The Institution now had its Standardisation Committees at work and it had become a supporting body of the Association. The Association was only too glad that the Institution would carry out this difficult work and co-ordinate the various ideas; he did not foresee any difficulty as to incorporating such parts of the Institution testing procedure as might be necessary for the somewhat restricted specifications which would soon be in course of preparation. The question of nomenclature, to which Mr. Duckham had referred, was of enormous importance to almost every industry, although the Members would, he was sure, agree that it was one of the most difficult subjects upon which to obtain an agreement. The Association was becoming recognised more and more as the national Standardising Body of the country. It could not hope to carry out the whole of the work itself, and as a result a great deal of it had to be done by devolution, the Association in many instances becoming, as it were, the co-ordinating influence, issuing the British Standards, at the same time giving due credit to the co-operating Institutions and Associations for their part in this national work.

Mr. Anfilogoff inquired whether the methods recommended by the Committee would become the British standards or whether it would be optional to the trade to use those methods or not.

The President said he presumed it was not within the power of the Institution to compel the use of any method, but if such an Institution made a recommendation that a certain method was the best for a particular purpose, and that a certain type of instrument complying with certain dimensions founded on existing instruments should be employed, and if such a body as the British Engineering Standards Association adopted those methods in their specifications, without in any way compelling people to adopt them, he thought that, *ipso facto*, they would become standard methods and be generally accepted.

Mr. Anfilogoff inquired whether the Committee were bringing forward their report only as a recommendation to the Institution, or whether their recommendations were "law."

The President thought that was not at all the case. The Members must bear in mind that the paper was merely a summary of the work that had been done up to date. The various Sub-Committees had put forward their recommendations, and he (the President) had not yet taken all their views into consideration, and tried to correlate them, and deal with the difficulties of overlapping.

The work was not complete, and he hoped it never would be complete, because if that ever occurred it would mean stagnation. What he thought would happen was that the suggested methods would, like the A.S.T.M. methods at first put forward, become tentative methods. The Committee brought the methods forward on the present occasion strictly in the sense of their being tentative. He was sure the Chairmen of all the Sub-Committees would agree with him in saying that they would welcome from the Members any suggestions or criticisms based on the paper, or any further suggestions. That was one of the objects with which the paper was written, in order that suggestions and criticisms might be received before the final report was published.

Mr. Anfilogoff said the President's statement had cleared the air. In connection with the suggested standardisation of methods, he noticed that all through the paper reference was made to the A.S.T.M. He noticed that the Committees had, quite rightly and wisely, adopted most of the tests of the A.S.T.M., which seemed to be suitable to this country. The greatest bulk of imports of petroleum products into this country was petrol, and he knew to his cost how difficult it was to correlate the tests of their friends on the other side of the Atlantic with the tests that were carried out in this country. The petroleum products were bought by people in this country from America generally on tests, sometimes conforming to the A.S.T.M., sometimes to the Bureau of Mines, and sometimes to other Departments, and the merchant in this country was frequently surprised when he found that the percentages and final evaporating points did not agree with the test on which he had bought the oil. He noticed that Sub-Committee 2 in recommending the distillation test had departed slightly from the A.S.T.M. He took that as a compliment, because they had practically adopted the method which he had used for the past twenty years. They differed from the test, however, in that they recommended a rate of distillation of one drop per second instead of two drops per second. From the academic point of view they might be quite right, but he noticed that in the statement they had made of the reasons why they had adopted the one drop per second, they said that the two drops per second rate of distillation gave less effective fractionation than at one drop per second. He put it to the Committee that in the ordinary 100 c.c. test taken by either a chemist, an engineer, an automobile engineer, a user or anybody else for the purpose of finding out the exact proportion of distillate boiling below 100 and the final evaporating point, the question of fractionation did not come in. Whether the drop coming over at 100 contained 2 per cent. boiling below 100 and 98 boiling above 100, did not affect

the matter at all. A quick method of distillation was obtained which gave certain results, and the results did not differ very far from the one drop per second method. Where the control chemist had to do 15, 16, 17, 18 or more tests a day for control work it made a great deal of difference whether the test took three-quarters of an hour or 20 or 25 minutes, more especially as practically nothing was gained by the longer period of distillation. The argument in favour of the two drop per second method was that the test took 20 to 25 minutes as against twice the length of time; there was a higher percentage of distillate at all temperatures; there was a lower final boiling point, and it brought the test in line with the U.S.A. standard test. He, therefore, thought it ought to recommend itself to the Standardisation Committee to adopt the two drops per second test rather than the one drop.

Dr. Dunstan, interposing, stated that the Committee had already decided to adopt the two drops per second test.

Mr. Anfilogoff said that the statement that Dr. Dunstan had just made was not contained in the report. With regard to the sulphur test, if a laboratory was going to be equipped with a bomb calorimeter for the purpose of obtaining calorific values and sulphur tests for fuel oils he did not see why the lamp method should be adopted for one grade of petroleum product and the bomb method for another, more especially as presumably the actual analysis took quite as long with the lamp method as it did with the bomb. He could not see any reason why the bomb calorimeter should not be adopted for all the products, since it was equally useful for petrol as it was for fuel oil, and eliminated personal error to a greater extent.

Mr. Arnold Philip said that, although he happened to be a member of one of the Sub-Committees, yet he nevertheless desired, with the President's permission, to make a short contribution to the discussion. This was particularly with regard to some of the criticisms of Standard Methods of test which Mr. Anfilogoff had made.

1. In the first place, the important question must be considered as to what constituted a Standard Method of test, from the point of view of a test which was to be used as a method for ascertaining whether a sample of material complied, or did not comply, with a given contract specification—*i.e.*, for the purpose of settling any dispute between the buyer and the seller of a given commodity.

2. In the speaker's opinion a Standard Method of test in this sense might, to a given analyst, be the best method of which he knew for making a particular chemical or physical determination, or, on the other hand, it might be almost the worst. But the opinion of the given analyst upon the accuracy or other merits or

demerits of a Standard Method of test was really immaterial. Such a Standard Method of test was intended to be merely the agreed method which the analyst would require to use to settle any dispute which might arise as to whether a delivery of material made under a contract which specified the use of the Standard Method must be received or rejected.

3. In this connection it was of interest to consider the manner in which the decision to recommend a given method of test for adoption as the Standard Method was arrived at in Committee.

4. In such a Committee a careful discussion of all the known methods of test first took place, and finally it became necessary to decide by vote which of the methods discussed, or what combination of these methods, should be adopted by the Committee for recommendation as the Standard Method of test. Possibly, and indeed probably, the Standard Method finally agreed upon in this manner was not considered to be the best by any member of the Committee, and probably might not be used for routine testing purposes by any member of the Committee. The decision arrived at by such a Committee as to what the Standard Method should be in any given case must necessarily therefore be in the nature of a compromise. Personally, he, the speaker, had his own ideas as to what were the best methods for making any specific tests and every other practising analyst probably had similar preferences; but no one need accept any Standard Method of test, whether recommended by the A.S.T.M. or any other authority, for use in the routine practical work of his own laboratory. What was desirable, however, was that they should all, as far as possible, adopt some agreed Standard Methods of test for deciding points in disputes over the character of deliveries of materials made under contracts. It would probably be only necessary to use such methods in a very small percentage of the samples examined, and it was only on account of the great value of Standard Methods of test for settling such rare disputes between buyer and seller that a general agreement as to their character was so desirable.

5. He further wished to support Mr. Duckham in the objection which he had raised to a too meticulous care being used in obtaining high percentage accuracy of test by any Standard Method.

6. As an example of a possible unnecessary accuracy he would call attention to the determination of the specific gravity of an oil fuel. This could, in general, be readily determined to within 0.0005, and with extra precautions, to within 0.0001, that is to say, that on an oil having a specific gravity of about 0.900, the determination would be correct to within about 0.055 per cent., or as little as 0.01 per cent.

7. Now, the knowledge of this gravity was intended for use chiefly in order to determine the weight of a cargo of oil, and in order to do this the gravity was required to be multiplied by the volume of the tanks containing the oil. But the percentage error of the product of two factors was equal to the sum of the percentage errors of the factors. Hence, if the percentage error of the tank volume was, say, 0.4 per cent., and the error of the gravity determination was 0.05 per cent., the error of the product, that is, the error in determination of the weight of oil from these factors, was 0.41 per cent. or 0.45 per cent. But the percentage error in the determination of the volumes of tanks, and especially of many ships' tanks, is of the order of as much as 1 per cent. This is owing to their irregular form and to the difference of their volume when full from what it is when empty, a difference caused by the strains set up by the weight of the contents.

8. In a paper recently read by J. W. N. David before the Society of Chemical Industry, Vol. 41, No. 17, September 15th, 1922, p. 295T, a new method of tank calibration is described, and the author claims that under favourable conditions the accuracy of his method is such as to give results with an error of about 0.2 per cent. of the correct volume. It is therefore evident that even with this exceptional accuracy of volume measurement it is hardly necessary to trouble about an error of 0.05 per cent. in the determination of specific gravity, and certainly to aim at reducing the error to 0.01 per cent. was quite an unnecessary refinement. The permissible percentage error of any test must, in fact, depend upon what use was to be made of the test figure when obtained.

9. The collection of the actual dimensions of existing so-called standard testing instruments, such as Flash Point Apparatus and Viscometers to which the President had referred, was, in the speaker's opinion, a most useful undertaking. On a previous occasion he had suggested, and he desired to suggest again, that it would be a great assistance in obtaining these figures if rough drawings of the instruments whose measurements were desired could be prepared showing dimension lines with blanks for the insertion of the actually observed measurements, at those points where it was desired to obtain them. Such drawings when once made could readily be prepared in multiple and issued to observers who were willing to fill them in. Such an arrangement would greatly facilitate the procedure of getting those measurements made, and would secure a uniform procedure which would permit of the results being readily compared.

Mr. Redgrove thought the paper was rather one for digestion than for criticism. While some of the methods that had been referred to were well known to chemists, others were in the nature

of a revelation. Whether what appeared to be revolutionary methods were the best ones to adopt only time could prove, but he was sure the lay members of the Institution would be only too glad to take the recommendations of the Standards Committee, and, if they proved to be the best, to adopt them. If they required subsequent correction or alteration, he knew the Committee would fall in line with the requirements of the industry. One of the most pleasing features of the paper was the international spirit in which the work had been carried out. It was impossible too closely to co-operate with those who supplied the goods in the majority of cases, because time and time again, as Mr. Anfilogoff had stated, the merchants on this side found themselves at variance with the suppliers in the United States. If the methods adopted were the same, not only in the United States but in this country, it would be of great advantage to all concerned. One of the most excellent features in the Report was the suggestion that a tolerance should be allowed. That was most desirable from the point of view of the operator, but he was afraid serious opposition would be forthcoming from legal and commercial men. From his experience of the legal and commercial mind, a chemical analysis was just like an addition sum. No allowance was made for the personal error, for differences of temperature and pressure and the various other factors which combined to thwart the accuracy of chemical analyses or physical tests. If only the Institution could induce people to accept the fact that a tolerance must be allowed it would be one of the most successful features of the work of the Standardisation Committee. In his opinion written criticisms of the paper, either destructive or constructive, would be most helpful, and he hoped the Committee were open to receive suggestions along those lines.

Mr. Gordon Pitt thought it was impossible on the present occasion for any direct criticism to be made on the methods briefly outlined in the paper, and that it was necessary for the Members to have time to think over the various suggestions made. Some of the recommendations had been sprung upon the Members, and if the Committee desired to know the opinions of the Members as a whole, he thought it would be necessary for written suggestions to be sent to the Secretary. Although he recognised that it was probably somewhat outside the scope of the original intentions for which the Committee was formed, it seemed to him a great pity that so representative and important an authority should have been brought together as was represented by the Committee without getting from them as much information as it was possible to obtain. He therefore suggested, on the lines hinted at by Mr. Anfilogoff, that though standard methods were now about to be laid down for

the assistance of the Members, and for the great benefit of the trade as a whole, it would be most helpful to a great many who did not possess the proper equipment or possibly the opportunity with regard to time, and at any rate in many cases not the interest to carry out very elaborate but very accurate methods of testing, if at the same time the Committee would recommend simpler alternative methods that could be brought into use for ordinary routine work, thus allowing a second line of standards of not such extreme accuracy, but of everyday value to most of the people concerned. He desired to give a personal illustration of what he meant. He had been troubled from two or three different quarters recently with regard to the vexed question of sulphur determination. On the one side a well qualified and highly expert chemist reported that a particular oil contained X per cent. of sulphur. From another quarter a second chemist had reported that the same oil tested in a manner similar to that which had been adopted by the first chemist, that the sulphur content was four times X. As he had no means of checking the figures himself, he referred the matter to a third chemist, who used the bomb method and found that the sulphur content was five times X.

Mr. E. H. Cunningham Craig said that he agreed with previous speakers that the paper represented a very fine piece of work well begun, but in looking through it he found that he was rather unfortunate. There were two things about which he wanted to know a great deal, the first being the determination of the saturated and unsaturated hydrocarbons. He found that the Committees had deferred dealing with that part of the problem, while as regards petrol the Committee were of opinion that at present there was no satisfactory way of making such determinations. Passing on to the next question which interested him greatly, namely, solubility tests upon solid materials, he found the statement made in the paper that that was a very vexed question which the Committee were investigating. He was glad to hear that because there were a few points in connection with it that might be of very great use, not only to the chemist but to the geologist. Something less than three years ago he had long discussions with a Member of the Institution, Mr. Guthrie, upon methods of making solubility tests upon solid material. They did not desire it to apply only to asphalt, still bottoms, etc., but also to oil shales, torbanites and cannels, and they arrived at a method that they thought would prove useful. He did not know whether the special Sub-Committee had considered all those different materials, but he thought it would be very useful if they did, because it would enable a line to be drawn through all the different materials that could be used in retorting. He would see that either Mr. Guthrie or himself placed

before the Committee their ideas upon the subject, which he hoped would prove useful to them.

Dr. Blackler said he had no criticisms to make in regard to the paper. The Standardisation Committees set up had dealt with a difficult subject in a very able and broadminded manner, and had endeavoured to co-ordinate and formulate methods that would prove to be both practical and reliable. With one eye on the future they had given flexibility to the scheme, which was a guarantee of its success.

Sir Frederick Black, K.C.B., said that as a layman he had looked at the paper from three different points. First of all, he wanted to see what was said about the percentage of asphalt in oils for Diesel engines. He was a little disappointed to find that the Committee said there was so much divergence of opinion as to the percentage that they could express no opinion on the method of test. It was well known that there were great differences of opinion on that point, but it seemed to him to be rather a difference of opinion as to specifications than as to testing methods. What he (the speaker) was suggesting was that if these were good standard tests for varying percentages, the tests should be specified in the Committee's brochure, and not be passed over because of varied specifications. The next point to which he wished to refer was the old question with which all his Admiralty friends were so familiar, namely, the viscosity of fuel oil. He remembered some of the old specifications used to say that the standard should be that the oil ran freely through a pipe of a certain diameter, five-eighths of an inch, he believed, and it was always felt that there would be a great difference of opinion as to what free running of the oil through the pipe really meant. No doubt the viscometer was an infinitely more exact method, but as an old Admiralty official, who had to buy the oil he used to put the question to Mr. Arnold Philip and the Engineering Department, whether it was quite the best test from the point of view of what the user required to know, namely, whether the oil would be pumpable at certain temperatures. After all, the user wanted to know whether he would have to put steam coils into the bunkers, and if he put them in how often he would require to use them, so that he could form some idea as to the expense which would be involved in keeping the oil liquid. He had always hoped that some day a kind of test would be evolved, more in the nature of a suction or pumping test, although he did not advocate discarding the use of the viscometer, which he admitted was a great step forward from the old rule-of-thumb method of watching the flow through a pipe of a particular diameter. That was a point he would very much like the Committee to keep in view, if not beyond their province. He thought the Members

would note with great satisfaction that in comparing the Redwood viscometer with the instrument that was principally used in America the Committee had sound points in favour of the British instrument. He hoped he might say that without infringing that fine spirit of internationalism which had been referred to by Mr. Redgrove. It was satisfactory to feel that the instrument associated with the name of the founder ot the Institution had been found in use more satisfactory than some of its rivals. In the opening part of the paper reference was made to some views expressed by Mr. Arnold Philip some time ago on the value of samples in relation to specifications. He was glad to see in the last paragraph of Dr. Dunstan's paper that the Members had not yet heard the end of that subject, and that the Board of Trade and other bodies were dealing with it. A point had not been referred to, so far as he knew, in regard to samples of oil and their value as contract samples compared with samples of materials that were perhaps not liable to change in composition during a long storage. He remembered shortly after the well was struck in Derbyshire at Hardstoft he was shown a bottle of oil from that well. A week or ten days later he saw the sample again, and then noticed that there was a very considerable amount of sediment of some kind or other which had settled out during that time. Supposing that sample had been put into the hands of the chemist of the eventual purchaser of the oil, and supposing the oil had been delivered in bulk fairly fresh from the well, what would have been the value of that sample? Samples of liquids in particular are only reliable for certain quantities that he thought should be specified and not to be taken for all purposes in examining bulk deliveries. Mr. Arnold Philip, in his wide experience, would remember many cases of difficulty that occurred where samples and specifications had both to be considered. He (the speaker) might give one illustration which came under his own notice. A small bottle of very finely selected lumps of charcoal had to be used for comparison with bulk supply. In addition to the sample there was a very precise specification, which said that in the actual deliveries there must be lumps of a certain size, the largest size being defined as passing through a sieve of a certain mesh, and smaller ones were defined in the same way. Judged by the sample the delivery would have been rejected; judged by the precise specification test of the two sieves of different meshes the delivery was acceptable. He hoped that the question of the precise use to which a sample of a volatile liquid liable to vary by keeping, could be put would receive special consideration, and its relation to specification tests be very carefully defined. He wished to compliment the President of the Institution upon the good work that had been accomplished in his term of office, as well as upon his skill

that evening in drawing the Chairman of the Standardising Committee from his modest obscurity. As far back as 1917 Mr. Duckham was one of the pioneers of standardisation work, and he had every right to feel proud of the results that had been achieved. He immensely appreciated the very fine work that had been done, which he ventured to think had lifted the Institution almost on to a higher level of practical usefulness and certainly had helped it to fulfil one of the main functions for which it was founded.

Mr. A. F. Gressler (New York) said he desired to take the opportunity of congratulating the Institution on the standardising work it was carrying out. It was a wonderful piece of work from the international standpoint, and he was particularly glad to hear the remarks of previous speakers that at any rate some of the methods that were adopted in America were also being adopted in a small way in this country. The chemical end of the oil business might be referred to as something new, and as new uses were made of oil, new specifications, of course, would be required. Those specifications naturally should be standardised in such a way that there would be no confusion and no occasion for any disputes regarding the quality that was supplied. Also with regard to the supplying and exporting of the various products of crude oil, such as motor spirit, kerosene, gas oil, lubricating oil, etc,. etc., to the different British interests from America, he was particularly interested in the question of standardising the necessary tests to determine accurately the quality of the product concerned. With regard to the question of samples, if a sample of oil was taken from a tank and was then sent over to this country, that was not an accurate method of arriving at a correct result because of the very nature of oil. He stated that he was not qualified to speak in detail on the subject under discussion, and could only say that he was very glad to have had the privilege of being present and listening to such an interesting discussion, also that he would be most happy to co-operate in every way within his power in furthering the good work.

Dr. A. E. Dunstan, in reply, said he desired, first of all, to clear up a possible misapprehension with regard to the paper itself. The paper did not pretend to give even a complete summary of all the work of the Sub-Committees; it was a very condensed account indeed, and that accounted for the fact that Mr. Anfilogoff did not realise that the Committee had made a recommendation in regard to the distillation test similar to that urged by himself. The paper only quoted certain arguments *pro* and *con*; there was a vast amount of material to be put on record that did not appear in the actual paper itself. Mr. Anfilogoff had asked a question about the position of the thermometer in the distillation flask and details about the general run of the test. All those details had been

settled, and would appear in the final specification. Another point to which he wished to refer was the fact that in using an apparatus like the Redwood or the Saybolt, or various colorimeters like the Lovibond or Wilson, the instruments had to a certain extent become locally standardised. In England one automatically thought of viscosity in terms of Redwood, and in the States in terms of Saybolt, and there was no particular purpose to be served in trying to foist one method over the other with so much local usage behind it. Therefore the Committee had taken Redwood as the particular type of instrument that should be used in this country, not because they desired to compare it with the Saybolt, but because they realised that the Saybolt would inevitably be the commercial viscometer in America, just as the Redwood would hold its place in this country. Several members had alluded to the possibility of sending in written communications. He desired to take the opportunity of saying, as Editor of the Journal, how much he would welcome written matter of any sort, shape or form, and he hoped that this statement would have the effect of encouraging prospective writers who were present that evening. As a matter of fact, there was a Correspondence Column in the Journal available for the ventilation of all matters naphthological, and he hoped that greater use would be made of it.

Naturally, any criticisms of method would be sent to the respective Sub-Committees concerned. There were one or two points of detail in the discussion to which he would like to refer. Obviously, the paper could not be discussed in full. He desired to clear up a few misapprehensions. It was stated in regard to the sulphur test that the bomb was the ultimate court of appeal. He did not agree with that statement, nor did his Committee. The Committee recommended the lamp method because of its superior accuracy. With a sulphur content of 0.006 per cent. there was no bomb yet manufactured that would give a result worth putting on paper. The question of tolerances had been referred to by several speakers. The Committee took a serious view about that subject, and the members might take it that every specification as issued would be provided with its appropriate tolerance. Reference had been made to the unsaturated contents and the solubility test. The question of the unsaturated content was under discussion, and ultimately a satisfactory test might be obtained, and if Mr. Cunningham Craig would send in his suggested solubility test to Committee No. 1 it would be most carefully considered. Sir Frederick Black had drawn attention to asphaltic content. That question was under discussion by the Diesel Engine Users' Association. The test itself was simple; it was really a question of building a specification on the test. With regard to the question

of the viscosity of fuel oil, personally he entirely agreed with the statement that had been made in regard to the inadequacy of the ordinary viscometer as a means of testing the pumpability of a fuel oil. At the same time it was difficult to see at the moment how a satisfactory pumpability test could be devised, but he had no doubt the Fuel Oil Committee would bear that point in mind when they came to draw up their final recommendations. A similar remark applied to what had been said with regard to the sampling of oil. That matter was also under discussion.

The President said he was sure the members would desire to express their thanks to Dr. Dunstan for being so kind as, he would not say to obey the command of Mr. Duckham, but the behest of Mr. Duckham to bring the subject before the meeting. He also desired to refer to a point to which Mr. Duckham had not referred with sufficient emphasis, namely, the indebtedness of the Standardisation Committee, and the six Sub-Committees, to Mr. B. G. Banks, who had so kindly undertaken to act as Honorary Secretary to the Standardisation Committee and the Sub-Committees.

The resolution of thanks was carried by acclamation.

Mr. Alexander MacDougall wrote as follows:—Dr. A. E. Dunstan appeared to emphasise the necessity of what has been termed "Tolerance," which, so far as one could judge, implied the "Tolerance of Errors," when aiming at the creation of certain Petroleum Standards. Whilst not professing to be an expert chemist, but as one who has had nearly thirty years' practical experience of the Petroleum Trade, my view is that if we are to have standards at all, they must be definite and fixed, without "Tolerance" of any kind.

Mr. E. C. Craven subsequently wrote: Any discussion of the standardised methods suggested by the Committee of the Institution must necessarily be governed by the actual degree of accuracy which specifications will necessitate. If the specification limits be extremely narrow, then methods of testing must be able to split these limits into at least ten parts. Take, for example, specific gravity; if the specification limits allowed of a tolerance of ·005 then it would be amply sufficient to determine the specific gravity of the body in question to ·001. In various portions of the paper, however, an accuracy to a unit in the fourth place of decimals is indicated. Such accuracy would probably only be necessary in case of dispute; but as this is probably one of the most important reasons why standardised tests are necessary, it follows that specific gravity should be rather more closely defined than has been done by Sub-Committee 2. As their definition stands at the moment, one

would naturally read "weights of equal volumes" to mean the true weights—*i.e.*, in vacuo—whereas probably nothing of the sort is intended. The difference of specific gravity in air and in vacuo of a petroleum spirit of about ·7 s.g. is ·0004, so that where the fourth place is concerned this correction is not negligible.

Coming now to the vexed question of distillation, the great point is as to what degree of fractionation is necessary. It must be obvious that as no quantitative degree of fractionation can be specified, it is advisable to reduce this to as near zero as possible, consistent with avoiding any splashing over of the liquid. Undoubtedly the Engler flask, when surrounded by a metal shield, fulfils these conditions admirably. Other forms of apparatus, such as have been recommended, for example, by E. Lawson Lomax (Journ. IV. 1918, 13, 15), are inadvisable, because too much attention must be paid to the dimensions of the attached fractionating device. If at any future time methods are discovered of interpreting the results of a distillation under increased artificial fractionating conditions, then it will be necessary to specify a standard fractional distillation with column. In regard to the rate of distillation, there is no doubt that two drops per second is a convenient rate, and far preferable to the one drop rate, especially where the modern fad of having the top of the thermometer bulb on a level with the top of the side tube is adopted. With a slow rate of distillation the vapours do not rise sufficiently to heat up the expanded portion of the thermometer capillary, and low temperature readings result. It is a matter for regret that the Committee recommend that the drop point be taken from the side tube of the flask, as the thermometer has really not time to rise to the temperature of the vapour under these conditions, especially if its bulb be large. In plotting results on squared paper, moreover, it is better to make the zero distilled point where the first drop enters the receiver, so as to bring this into line with all the other readings. In the argument given for two drops per second it is stated that the test takes 20–25 minutes. This is manifestly impossible, as at the maximum rate of distillation given—namely, 5 cc. per minute, and a minimum pre-heating period of five minutes—the minimum time is obviously 25 minutes; and in practice 30–35 minutes is far more usual. It is also stated that a higher percentage distillation is obtained at all temperatures, which, again, is either a misprint or obviously absurd.

The Committee are to be congratulated on the very able manner in which they have dealt with such a multiplicity of tests, and also on having the results of their work put so ably and lucidly before the Institution by Dr. Dunstan.

The President, having announced that the next Meeting would be held on Tuesday, November 14th, it was hoped in the

theatre of the Royal Society of Arts, when Mr. Albert Millar would read a paper on: "The Galician-Canadian Pole Tool Drilling System," the Meeting terminated.

The Sixty-sixth Meeting of the Institution of Petroleum Technologists was held at the House of the Royal Society of Arts, John Street, Adelphi, on Tuesday, November 14th, 1922, PROF. J. S. S. BRAME, F.I.C., F.C.S., President, occupying the Chair.

The members of Council present were Sir Thomas H. Holland, Mr. H. Barringer, Mr. Arthur W. Eastlake, Mr. T. C. Palmer, and Mr. Robert Redwood.

The President said it would be within the recollection of the members that Mr. Millar had given them a very excellent paper as recently as last April, on the Petroleum Industry of Galicia, and he thought Mr. Millar's present paper might be looked upon as complementary to that.

The Council appreciated Mr. Millar's efforts in preparing those papers, because they entailed a tremendous amount of work. He should also like to take the opportunity of saying that the Council hoped that Mr. Millar's excellent example of presenting two papers in two succeeding Sessions would stimulate other members of the Institution so that many of the difficulties which the Publication Committee suffered from would, to a large extent, disappear.

The Galician-Canadian System of Pole Tool Drilling.

BY ALBERT MILLAR, A.M.I.Mech. E. (Member).

INTRODUCTION.

DRILLING SYSTEMS.

Although many drilling methods have been tried on the Galician oilfields, the Canadian system is exclusively used to-day. It lends itself admirably to drilling in formations which change frequently from soft to hard and vice versa, necessitating immediate change of the speed at which the drilling tools are working, otherwise a small or crooked hole would be drilled. In cases where one side of the hole is hard and the other soft, with this percussion system the drill can be maintained in one position until the hard part is drilled up. With the pole-tool system, every change in the formation becomes at once apparent to the driller, which important

fact signifies a great deal. On the Boryslaw-Tustanowice-Mraznica Field, the formation often changes several times within a few feet, as it does practically throughout the whole of Galicia, and the strata dip very steeply as much as 15 to 45° or more.

Loose belts are one of the chief features of the Canadian drilling system, and allow for much give and take, thereby greatly reducing the strain on the rods, casing, rig and derrick. The amount of power necessary to be transmitted by the belts is under complete control of the driller, who tightens or loosens them by means of jockey pulleys, and when an extra load is suddenly brought on, the slipping of the belts which takes place prevents breaking of poles or ropes or the tearing apart of the casing.

The belts can also be used to supplement the braking power of the ordinary brakes, which are fitted to the draw and sandline spools, by simply running the belts in the opposite direction to that of the spool when lowering in the bailer, tools or casing.

Among other drilling systems which have been tried are the following:—Cable drilling with manilla or wire ropes. The former was not satisfactory as the drilling necessitated a wet hole being kept. Wire ropes had certainly an advantage over manilla, but drilling by the rope system was, on the whole, far from being a success, as crooked and "flat" holes were often drilled. Failure was in all probability not due to the system, but to the fact that instead of properly constructed and specially adapted rope drilling outfits being used, the ordinary Canadian rig was only slightly altered and no extra spool introduced, consequently results proved far from satisfactory.

Two other factors tended to lessen the chances of success with the rope system: firstly, instead of using specially constructed bits, the ordinary eccentric bit was used, which evidently did not rotate regularly, with the result that the hole drilled was not round, commonly known as "lumpy" or "flat." Secondly, the drilling rope was used for sand-pumping, and after the latter operation the rope was more or less loosely and irregularly wound on the spool, so that when the drilling tools were again coupled on and being lowered into the well, the weight caused the loosely wound coils to jump and wedge themselves; this undue strain not only shortened the life of the rope, but was the cause of many fishing scrapes.

The "Fauck" water-flush system has also been tried, and very fast drilling has been accomplished, but generally the holes drilled were crooked so that it became impossible to continue the bore hole with the pole tools, so this system was discarded. Many oilmen were of the opinion that the oil-bearing strata were partially flooded with water through this means of drilling. Whether this opinion

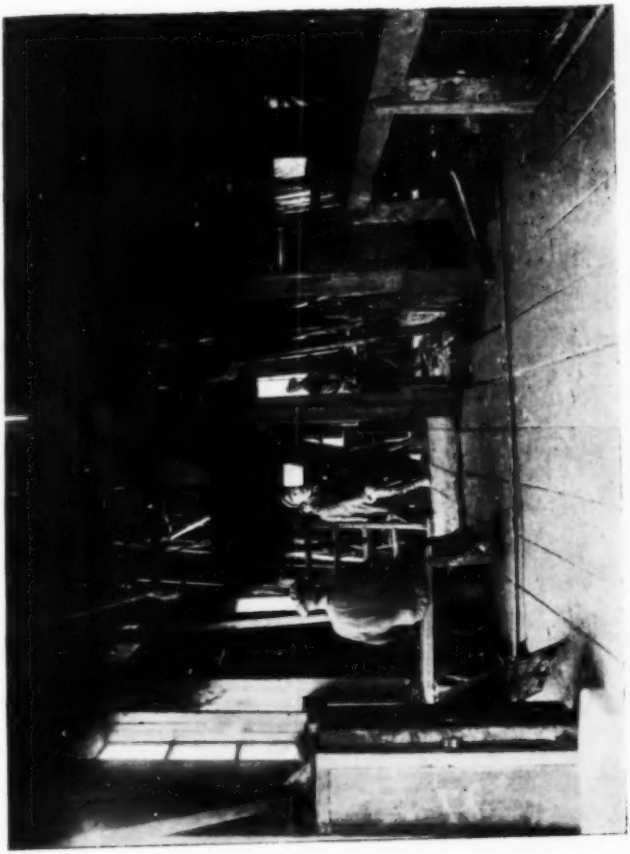


FIG. 1.

INTERIOR OF GALICIAN-CANADIAN DRILLING RIG, SHOWING DRILLER ON THE POINT OF LOWERING IN BAILER.

FIG. 2.
HEAVY TYPE DERRICK IN COURSE OF CONSTRUCTION.

was justified or not, it is difficult to say; nevertheless, the fact remains that several wells drilled by this method in richly productive areas turned out to be practically "dry" holes. It is quite possible the head of flush water was sufficient to overcome the oil and gas pressures when the oil sand was tapped, the column of liquid being anything from 1,000 to 1,250 metres or more, depending on the depth of the well.

The "Raki" and "Lapp" water-flush systems were also given a trial, but were eventually abandoned for more or less the same reasons.

It is quite possible, had mud flush been used instead of water with the various flush systems, better results would have been obtained. At the point of contact of shale or clay beds with layers of hard sandstone the action of the water flush was to wash out large and small cavities, which left the drill unsupported in the direction of the dip, where support was most necessary. The action of the mud-flush would have had the opposite effect, and with a little more care on the part of the driller, when running from hard into soft strata and vice versa, a straighter hole could have been kept.

In 1913 the "Rotary" system was given a trial, and two wells were partly drilled by this method. The territory where the drilling was carried out was by no means difficult. No. 1 Rotary Well was drilled to nearly 600 metres in three months, with 14 in., 12 in., 10 in. and 9 in. strings of casing, and the last dimension became "fixed." The rotary had to be abandoned owing to the crookedness of the hole, and an attempt was made to drill deeper with pole tools. With difficulty the 7 in. casing was passed through the 9 in. column and drilling was then continued, but the well had to be abandoned eventually owing to the total collapse of the 10 in., 9 in. and 7 in. casings, the cause of this being large quantities of water which had collected behind the 10 in. and 9 in. casing columns in the huge cavities washed out by the flush liquid. A Canadian pole-tool rig drilling alongside made 530 metres in two months, using 14 in., 12 in. and 10 in. casing, the latter dimension being set at 530 metres.

No. 2 Rotary Well was drilled with 14in. dia. bits to 40 metres, but in inserting the casing it was found it would only go to 28 metres; the bore hole was then underreamed and the casing forced in, but the hole was crooked. Drilling was then continued with 12 in. bits and a depth of 403 metres was reached, but it was found the casing could only pass to 129 metres, and although underreaming was resorted to, it could not be forced lower. A 10 in. string was then put in, but great difficulty was experienced in getting it down to 390 metres, or 13 metres short of the bottom

drilled for taking 12 in. casing. The well had then to be abandoned, as the hole was so crooked that the 9 in. casing would not pass through the 10 in. column. The table below shows time made in sinking this well :—

Fastest drilling with the rotary	..	29	metres in 24 hours
Slowest " " " "	..	60	ctms. " " "
Average drilled " " "	..	7·5	metres " " "
Drilling during 1st month	"	.. 260	"
" " 2nd "	"	.. 143	"

Plus 15 days inserting casing; therefore the total drilled was 403 metres in 2¼ months.

When the second well, drilled by the rotary, was abandoned, a Canadian pole-tool rig was erected, the site being only 20 metres away from the rotary. The progress made was :—

1st month	..	..	..	..	..	..	228 metres
2nd "	..	..	..	..	..	..	172 "

or 400 metres drilled and cased in two months. The depths to which the casings were taken were :—

12 in. casing to 113 metres
10 in. " " 404 " *moveable*

Drilling with the Canadian pole-tool rig—

Fastest	..	..	..	..	12	metres in 24 hours
Slowest	..	..	..	..	2	" " " "
Average metres drilled	..	..	..		7·3	

This well eventually attained a depth of over 1300 metres.

The apparent failure of the "Rotary" system was due to certain factors. First of all, the American drillers tried to break records already set up with the pole tools in territory of which they had not the slightest knowledge, and, no doubt, their impatience in trying to force the drill through hard strata, by putting on unnecessary weight, was to a great extent the cause of the trouble which was experienced through the smashing of bits and twisting off of the drill stems. One must also recollect that, in general, the drillers were not assisted by the good will of local oilmen, many of whom condemned the system even before it had been given a trial. On the other hand, the drillers were to blame to a certain extent, as they were not willing to accept sound advice proffered by experienced men who were thoroughly acquainted with the peculiarities of the formation to be penetrated.

Owing to the slow progress made with the Canadian system in the southern parts of the Boryslaw-Tustanowice field, where drilling is extremely difficult, and the time taken together with increased costs of working, a general movement is being made to give other systems a trial. One well is to be drilled by the "Rotary," another with a combination of "Rotary and Cable Tools," and a third with "Cable Tools" only. This is a step forward,

FIG. 3.

(a) Bent shank to give greater eccentricity—very often the cause of broken pins and shank fractures. Foredrill not dressed at right angles, causes wedging of bit and retards drilling. (b) Insufficient wing clearance will drill small hole. Foredrill too small, gives very little chance of drilling large round hole. (c) Foredrill too short, and rib of wing too sharp, will drill a small hole. (d) Badly dressed foredrill will wedge bit and retard drilling. (e) Foredrill will wear quickly and badly dress wings, will drill a small hole. (f) Badly dressed foredrill properly dressed bit. (g) A properly dressed but which will tend to drill a slightly larger hole than ⅛". (h) Shows a properly dressed wing. (i) Shows a wing normally worn. (j) Shows a badly worn wing, and from it one may learn that the hole is drilling crookedly. (k) Shows cutting edge of wing unusually worn. (l) Shows cutting edge of wing badly worn and points to either a tramp or crooked hole. This is especially the case if the face or rib is grooved instead of being polished.

and results will be eagerly watched, but it is to be hoped that the drillers and those in charge will not set out with the idea of setting up new records. To make either of these systems a success, alterations may have to be made to adapt them to suit local conditions, and this can only be satisfactorily accomplished when trials are carried out with the utmost thoroughness, and careful observations should be made.

Up to the present electricity has not been used for power purposes, but since the war a great deal of headway has been made with the preliminaries, and two large oil companies are preparing to give it a trial. One of these has its Generating Station situated in south Tustanowice; there are two turbo-generators, each capable of generating 2600 kilowatts. The steam plant consists of three "Garby" Watertube boilers, each having 280 sq. metres heating surface and a working pressure of 16 atm. The steam will be superheated to 350° C. for the "Curtiss" turbines. Three-phase current at 3000 volts will be generated, and this will be stepped down to 1100 volts for drilling purposes, and at each well a transformer will be installed.

The work of changing over a number of wells at present using steam power to electricity is in course of progress, and the results will be watched with the greatest interest.

Several wells are now being drilled by Diesel motors; the drilling progress is somewhat slower than that with the steam engine: the deepest well is now over 500 metres, and, so far, the greatest satisfaction has been given. The engine used in this case is a single-cylinder vertical engine of 60 h.p., with possible speed variations of from 90/220 r.p.m., this being controlled from the driller's bench. Light crude or gas oil is used as fuel, with air injection, and the consumption averages 1400 klgs. per month, or approximately 2.25 klgs. per hour.

DERRICKS AND RIGS.

Canadian Pole Tool System.

The derricks and rigs are constructed of wood, this not only being a cheap method of building, but is also strong and durable. Should a derrick become strained, it can easily be strengthened by what is known as "doubling," which is nothing more or less than building a derrick around and on to an existing derrick in such a way that the one becomes part of the other. When it is anticipated that difficult drilling will be encountered, and heavy strings of casing will have to be handled, the derricks are doubled at the outset. Owing to the flexibility of the wooden structure and the ease with which sudden shocks are absorbed, a great deal of undue

wear and tear is taken off the drilling rods, casing and lifting tackle. Big pulls can be taken with six-sheave blocks which would spell disaster with any construction of a more rigid nature. Elasticity is a most important point, and one which cannot be too much appreciated when drilling deep wells of over 1300 metres, where a column of casing can weigh up to 70 tons, and to this must be added ground friction, which is an unknown quantity, and when it is several hundred metres in the ground, and has a tendency to become fixed (frozen), it may almost equal the weight of the casing. The following material is required for building a derrick and rig of standard Galician type.

1. *Foundation timbers under derrick and rig.*

11 pieces	10 in. × 12in.	..	..	6 metres	Mud sills and derrick sills
4 „	12 in dia.	..	..	9 „	
2 „	12 in. × 12 in.	..	..	6 „	

Derrick framework.

18 pieces	3 in. × 9 in.	..	..	5 metres	Derrick legs
50 „	3 in. × 12 in.	..	..	5 „	
40 „	2 in. × 12 in.	..	..	6 „	Girts
20 „	2 in. × 8 in.	..	..	6 „	Braces
25 „	2 in. × 8 in.	..	..	5 „	„
15 „	2 in. × 8 in.	..	..	4 „	„

Derrick platforms and galleries.

6 pieces	2 in. × 8 in.	..	..	6 metres
6 „	2 in. × 8 in.	..	..	5 „
12 „	2 in. × 8 in.	..	..	4 „
10 „	2 in. × 12 in.	..	..	6 „
5 „	2 in. × 12 in.	..	..	5 „
5 „	2 in. × 12 in.	..	..	4 „
10 „	2 in. × 6 in.	..	..	6 „
5 „	2 in. × 6 in.	..	..	5 „
5 „	2 in. × 6 in.	..	..	4 „

Crown block.

6 pieces	2 in. × 12 in.	..	..	5 metres
6 „	2 in. × 10 in.	..	..	5 „
6 „	2 in. × 8 in.	..	..	5 „
4 „	2 in. × 4 in.	..	..	5 „

Roof and boarding in of crown.

15 pieces	2 in. × 6 in.	..	..	4 metres
35 „	2 in. × 4 in.	..	..	4 „
12 „	2 in. × 10 in.	..	..	4 „
2 „	3 in. × 10 in.	..	..	4 „
4 „	1½ in. × 12 in.	..	..	4 „
60 „	¾ in. × 12 in.	..	..	4 „
10 „	¾ in. × 4 in.	..	..	4 „

Two rolls of roof felting (or sheet iron)

Door frames and boarding for derrick sides.

2 pieces	6 in. × 6 in.	..	..	10 metres
8 „	2 in. × 8 in.	..	..	5 „
180 „	¾ in. × 12 in.	..	..	5 „

Derrick floor.

4	pieces	12 in. × 12 in.	.. ..	6	metres
20	„	3 in. × 12 in.	.. ..	6	„

Detritus shoot in derrick with 6 metre channel.

8	pieces	1½ in. × 12 in.	.. ..	6	metres
3	„	1 in × 10 in.	.. ..	4	„
4	„	2 in. × 6 in.	.. ..	6	„

Gangway in front of derrick.

2	pieces	8 in. × 10 in.	.. ..	5	metres
8	„	3 in. × 12 in.	.. ..	6	„

Draw works.

1	piece	14 in. × 14 in.	.. ..	5	metres	Bearing beams, samson post, braces, and snatchpost
5	„	14 in. × 14 in.	.. ..	6	„	
3	„	14 in. × 14 in.	.. ..	7	„	
2	„	14 in. × 14 in.	.. ..	8	„	
3	„	10 in. × 18 in.	.. ..	4	„	
1	„	14 in. × 18 in.	.. ..	6	„	
1	„	14 in. × 14 in.	.. ..	6	„	
1	„	14 in. × 14 in.	.. ..	7	„	
2	„	8 in. × 8 in.	.. ..	6	„	
3	„	10 in. × 12 in.	.. ..	4	„	
5	„	10 in. × 12 in.	.. ..	6	„	
2	„	10 in. × 12 in.	.. ..	7	„	
2	„	8 in. × 8 in.	.. ..	6	„	

Walking beam and oak liner.

1	piece	14 in. × 22 in.	.. ..	7	metres	
1	„	6 in. × 14 in.	.. ..	2	„	Oak

Trough and covering for sandpump spool.

2	pieces	6 in. × 6 in.	.. ..	7	metres
6	„	2 in. × 8 in.	.. ..	5	„

Foundation under drilling engine.

9	pieces	12 in. × 12 in.	.. ..	6	metres	Engine sills
1	„	12 in. × 14 in.	.. ..	5	„	„ block
2	„	12 in. × 14 in.	.. ..	6	„	„ „

Drilling rig and engine house.

3	pieces	6 in. × 6 in.	.. ..	7	metres	
50	„	2 in. × 6 in.	.. ..	4	„	
20	„	2 in. × 6 in.	.. ..	5	„	
30	„	2 in. × 6 in.	.. ..	6	„	
20	„	2 in. × 4 in.	.. ..	6	„	
140	„	¾ in. × 12 in.	.. ..	4	„	
100	„	¾ in. × 12 in.	.. ..	6	„	
50	„	¾ in. × 4 in.	.. ..	5	„	
18	rolls of felting (or sheet iron)					
25	pieces	2 in. × 12 in.	.. ..	6	„	Rig house, floor, galleries and steps
10	„	1½ in. × 12 in.	.. ..	4	„	
10	„	2 in. × 4 in.	.. ..	6	„	
12	„	2 in. × 6 in.	.. ..	6	„	
5	„	2 in. % 10 in.	.. ..	6	„	
25	„	2 in. × 6 in.	.. ..	6	„	Engine house floor
15	„	2 in. × 4 in.	.. ..	6	„	
50	„	1½ in. × 12 in.	.. ..	6	„	

Gangways with hand rails.

6	pieces 6 in. dia...	.. 6	metres long	
15	„ 1½ in. × 12 in.	.. 4	„ „	
12	„ 2 in. × 5 in.	.. 6	„ „	
7	window frames with glass			
3	pieces 6 in. × 6 in.	.. 6	„ „	Oak for wedges

400 kilos nails, as follows:—

75	kilos	4 in.
150	„	5 in.
25	„	6 in.
40	„	7 in.
120	„	roofing and other nails

RIG IRONS.

Where possible, everything is made of wrought iron, mild and cast steel, cast iron only being used where absolutely necessary.

List of Parts with main dimensions.

1 Steel counter shaft with crank, 138 m/m dia. by 3200 m/m long. The crank is of cast steel, with three taper crank pin bores 100 m/m largest dia.
1 Crankpin, 100 m/m dia., with key.
1 Oak crankshaft bearing (babitted), 1000 m/m long, 250 m/m wide, and 138 m/m dia.
2 Ditto. 750 m/m long, 200 m/m wide, and 138 m/m dia.
1 Wrought iron bearing plate, 20 m/m thick, 1000 m/m long, and 250 m/m wide.
2 Ditto. 750 m/m long, 200 m/m wide.
3 Lubricators, cup type.
1 Wrought iron Bandwheel, 2000 m/m dia., 400 m/m wide. 138 m/m boxing.
1 Ditto. 1400 m/m dia. 400 m/m wide, 138 m/m boxing.
1 Ditto. 1250 m/m dia. 400 m/m wide. 130 m/m boxing.
3 Bandwheel keys.
1 Wrought iron Draw Spool, 1750 m/m between bearings, dia. of shaft 75 m/m. Drum 370 m/m dia. Pulley 1400 m/m by 400 m/m. Brake ring 1200 m/m dia. by 135 m/m wide.
1 Sandline Spool, 2500 m/m between bearings, dia. of shaft 75 m/m. Drum 375 m/m dia. Pulley 1100 m/m by 400 m/m. Brake-ring, 1000 m/m by 135 m/m.
1 Steel Brake-band, copper-lined, 135 m/m wide, for Draw Spool.
1 Steel Brake-band, copper lined, 135 m/m wide for Sandline Spool.
4 Cast iron bearings, babitted and ring lubricated, for Draw and Sandline Spools.
2 Jockey pulleys, with 50 m/m dia. shafts and bearings.

4 Cast iron boxings for Jockey Pulley.
2 Jockey pulley Draw Irons and two levers, for Jockey Pulley Countershaft.
1 Lever-shaft.
1 Cast iron Rope Pulley, with 70 m/m dia., axle 600/480 m/m.
1 Ditto 780/660 m/m dia.
1 Ditto 1200/1100 m/m dia.
1 Double cast iron bearing, babitted and ring lubricated for Crown Pulley Wheels.
2 Cast iron upright bearings, babitted and ring lubricated, for Snatchpost Pulley.
4 Cast iron bearings, babitted and ring lubricated, 70 m/m dia. for Crown Pulley Wheels.
2 Cast iron bearings, babitted and ring lubricated, 70 m/m dia. for Sandline Pulley.
1 Set of three Joists, 350 m/m high, 2500 m/m long, bolted together.
1 Set of two Joists, 300 m/m high, by 2500 m/m long, bolted together.
10 Stirrups for Crown Pulley Bearings.
1 Chain Jacket with double central guide, for 32 and 35 m/m dia. chains.
1 Walking beam shaft, 120 m/m dia., for 14 in. or 12 in. Walking Beam.
2 Cast iron bearings for Walking Beam Shaft.
1 Wrought iron Walking Beam Bedplate.
2 Stirrup bolts, 25 m/m dia. for fastening shaft to Walking Beam.
1 Cast steel Slipper-out, with chain wheel and hand chain.
1 Pitman for 12 in. or 14 in. Walking Beam, forged in one piece, shaft dia. 60 m/m; also fitted with bronze bearings and lubricating cup.
1 Oak Bearing for Pitmanshaft, babitted.

Drilling Engines.—The drilling engines in use are of the, more or less, common type used on most oilfields. They are single-cylinder engines and made in two sizes, being rated at 45 and 60 h.p., the smaller having a cylinder diameter of 300 m/m and a stroke of 360 m/m, whereas the secondand larger type has a cylinder diameter of 350 m/m and stroke 400 m/m. Both types are fitted with a heavily constructed flywheel and belt pulley of 700 m/m dia. and 400 m/m face. These engines are fitted with a lightning throttle valve.

Belts.—All belts used are of woven camel hair, either 12 in. or 14 in. wide, by 14 m/m thick, the length of the engine belt is from 16 to 17 metres, sandline spool belt 11 metres, and the tool-line spool belt 9 metres. Various belts have been tried, such as leather chain belts, steel chain belts (a war-time product), and canvas ply

belting, etc., but nothing has given such satisfaction as the ordinary good camel hair belt, although well-made leather chain belts have run as long as 7 to 8 months.

Boilers.—The locomobile boiler is the most favoured type on the Galician Oilfields and is built in one type and size only, with a heating surface of 60 sq. metres and working pressure 10 atm. The firebox is of the "Fox" corrugated type of 1000 m/m dia., and 2300 m/m long, thus eliminating all stays and their attendant objectionable features.

Many of these boilers are fitted with steam driers arranged in the upper part of the smoke box and lower part of the smokestack. As an all-round boiler for hard work and requiring little attention it is difficult to beat; they can be fitted with firebars for burning wood or coal as required, but naturally give the best results with oil or gas firing. It is possible to force these boilers over long periods, running into months, with little or no ill effect, to an extent which would be absolutely disastrous to any other type, especially those having stayed fireboxes. Under ordinary working conditions this class of boiler can evaporate 2200 lbs. of water per hour at 120 lbs. gauge pressure, and when forced—3000 lbs. Using crude oil as fuel, the quantity of water evaporated per lb. of oil is from 10 to 15 lbs., depending on the condition of the boiler and feed-water temperature. To obtain the best results with this type of boiler, when using oil or natural gas as fuel, it is necessary attention should be given to the placing of the brickwork in the firebox. As previously mentioned, the locomobile boiler is first class where hard work is required, little attention given, and where the water is not good, which is often the case on an oilfield, therefore it is the ideal type for prospecting purposes. As soon as the well has been brought into production, necessitating the running of a swabbing plant continuously (and the well being swabbed may be from 1000 to 1700 metres deep), as well as heating and manipulating oil, running pumps, gas exhaustor plant, dynamos, etc., this type of boiler is uneconomical owing to the duplication necessary; therefore, it is advisable when production has been struck, or where a number of drilling wells can be run from one central installation, to do away with the small duplicated units, in favour of one or more large boilers which can be run with greater economy in fuel and upkeep expenses. Many of the oil companies now operating in Galicia have at last commenced to realise this, and, instead of having as many as five or six locomobile boilers grouped together under one roof they are installing large bricked-in boilers with a view to obtaining higher efficiency. The type of boiler being adopted by many companies is that known as the "Tischbein," which is well adapted to oilfield work, having both large

water and steam spaces, and the products of combustion can be fully utilised; great care, however, must be taken when erecting and bricking-in these boilers. The water for the supply of the Boryslaw-Tustanowice-Mraznica field is collected from the various streams passing through the field, into which is let the sludge and refuse from the wells. The one drawback to the bricked-in boiler with complicated flues, when using oil or gas fuel, is the chance of explosion, the cause of this is generally carelessness on the part of the firemen through allowing unburnt gases to collect in the bricked flues when firing is interrupted, and restarting before the accumulated gases have been given time to disperse. To minimise the damage which might thus be caused it is advisable to place safety "explosion doors" in such places where the gases are most likely to accumulate and the effects of the explosion most severely felt. There are other types of boilers in use, such as the Babcock Willcox and Duerr Guehr, and both have given satisfaction. Under-fired tubular boilers have also been used, they are, however, not a practical type, as that part of the boiler subjected to the greatest heat, is also that part where the sludge collects; the boiler itself is liable to very uneven expansion of the shell plates, therefore trouble is often experienced.

Superheating.—Steam driers have been used on the oilfields for many years in conjunction with the locomobile boiler, they are placed in the upper part of the smokebox and lower part of the smokestack. For several reasons superheated steam has been very little used, as the engines, pumps, etc. are not constructed for its use and the trouble experienced in effectually insulating the steam lines against risk of fire. Practically all insulating materials are porous, and in the neighbourhood of the well soon become saturated with oil, and although sheet iron has been used to protect the insulating material, still the oil finds its way in, consequently the use of superheated steam is more or less dangerous. Of course, the temperature could be regulated, but anyone knowing the Slav fireman will at once realise how difficult it would be to carry this out successfully.

Steamlines—Insulating Materials.—Steamlines and their insulation are seldom given the attention they demand, in fact, they generally appear to be the most unnoticed and neglected part of the installation. The steamlines are very often either too small or too large in diameter, the number of superfluous fittings used is astounding, and it has certainly required a considerable amount of ingenuity on the part of the "fitter" to get them all in. As these fittings are generally of the cheapest and poorest type it is found that very soon after the steamline has been put into work it is leaking throughout its entire length, and great losses are caused

by the use of cheaply and badly constructed valves. The chief loss, however, is through bad insulation. Quite three-fourths of the steamlines on the Galician oilfields are insulated by means of twisted straw wound round the piping; this in turn is plastered over with clay or mud and protected by inferior tarred felting. Flanges and joints are usually left exposed and one often sees many metres of pipeline entirely unprotected, with the result that in many cases the steam consumption is over 75 lbs. per h.p. hour. The fuel consumption statistics show that in 1920 over 49,500 tons of crude oil were consumed, or, one-twelfth of the production, and in 1921 over 49,000 tons representing approximately one-tenth of the total production. In addition to this, over 400 cub. metres of gas per minute were also burnt. The above figures apply only to the Boryslaw-Tustanowice-Mraznica Field, and emphasises the enormous wastage which is going on. A large amount of money is being spent in preparing to electrify parts of the field, other prospectors are advocating the use of internal-combustion engines, and all deplore the heavy costs in connection with drilling and producing to-day, yet, strange to say, no one seeks an immediate partial solution of the problem by dealing with the steam generating and power plant in such a manner as to ensure the greatest working efficiency and economy. It would be difficult to find anywhere the first principles of steam and mechanics so neglected as they are on the Galician oilfields. Fuel consumption could be greatly reduced, and the cost of production thereby cheapened, in the writer's opinion, if more care was taken with the existing plant until steam is superseded by electric motors or internal-combustion engines.

DRILLING BITS.

(Canadian Pole Tool.)

The eccentric bit was first used in Galicia about 30 years ago and is the type principally employed at the present time. If sufficient care is taken to see that the bits are of the right dimensions and properly dressed, no trouble should be experienced in drilling both a straight hole and one of sufficient diameter to allow the casing to follow on easily, with the larger sizes.

Crooked or small holes can be avoided, and a great deal of the time taken up in underreaming saved, if, when the bit is withdrawn from the borehole for re-dressing, it is carefully examined and the signs of wear rightly interpreted. Small or crooked holes are often caused by carelessness on the part of the driller when running into hard strata or vice versa, running a bit too long,

mis-reading the wear of a bit, and also by badly shaped and badly dressed bits.

When boring in hard strata, it is advisable to keep the bits as thick as possible, whereas for clays a slightly thinner bit may be used with advantage; as a rule the eccentric bit is too thin, and the outer wing, or underreaming part, far too narrow. An improved eccentric bit for use when drilling through hard sandrock, limestone or quartz, is constructed so as to give longer life to those parts which wear the quickest, and which, when they have become worn, are a frequent cause of a hole being drilled out of truth.

The inside part of this improved bit is made with a "rib" or "wing," which counteracts undue wear, and at the same time retards the speed of the drilling of the foredrill, thereby giving the wing or underreaming part of the bit a fair chance to properly perform that work for which it was constructed, *i.e.*, the drilling of a clean round hole. The winged portion has by far the most work to do, and if it is not given sufficient time to do it in, the result is—a small and ragged hole requiring much underreaming, consequently slower drilling progress. To achieve good results with maximum drilling speed, the bits should be dressed in the following manner:—

(*a.*) Length of foredrill one-half the diameter of the casing.
(*b.*) Width of foredrill, two-thirds of total width of eccentric bit.
(*c.*) Thickness, 3 in.—4½ in. for the larger sizes.
(*d.*) The wing should be made as wide as practicable, in fact, the wider the better, especially when one is drilling through steeply inclined strata.

(Eccentric Bit Dimensions.)

Size. in.	Collar dia. m/m.	Length overall. m/m.	Total width of cutting edge. m/m.	Weight in kilos.
14 ..	160 or 180 ..	1200–2000 ..	333 ..	240–270
12 ..	160 „ 180 ..	1200–2000 ..	285 ..	230–270
10 ..	140 „ 160 ..	1200–2000 ..	247 ..	175–210
9 ..	140 ..	1200–2000 ..	212 ..	150–190
7 ..	105 „ 125 ..	1200–2000 ..	175 ..	125–145
6 ..	90 „ 105 ..	1200–2000 ..	143 ..	80–110
5 ..	80 ..	1200–2000 ..	115 ..	60– 90
4 ..	60 „ 80 ..	1200–2000 ..	85 ..	40– 60

Hoof Bit.

This bit, as the name implies, is shaped like a hoof and is used with much success for straightening out holes which have become crooked when drilling in steeply inclined strata, or running out of a soft formation into a harder one. It is also a very valuable tool for use when side-tracking casing and lost tools, and for this last

purpose there is nothing better. The angle at which the hoof is dressed depends on the work to be accomplished; when starting to sidetrack casing or lost tools, an angle of 30—35° is the best, and as the work progresses, this is reduced to about 20°. When straightening a crooked hole, the angle of dressing should be kept as small as possible, or about 5—8°.

Underreamers.

The underreamer plays almost as important a part in the drilling of deep wells with the Canadian system as does the bit itself. The type used is that known as the "Fauck" double underreamer. The "dogs" (cutters) are made of tool steel, such as would be used for cold chisels. It is not advisable to use cast steel owing to its brittleness, as, should they break, a good deal of time would be lost in either fishing, sidetracking or drilling them up. These underreamers are made for use in the following size casings:—

Size 1,	for	12 in., 10 in. and 9 in.	casing
„ 2,	„	7 in.	„
„ 3,	„	6 in.	„
„ 4,	„	5 in.	„
„ 5,	„	4 in.	„

It is now becoming a general practice, when underreaming 7 in. and smaller holes, to screw together two double underreamers; by doing this the work is not only accomplished much more quickly but a vertical hole is obtained. An additional advantage is that the reamers can remain working much longer before withdrawal for re-dressing, which means a great saving of time. A hole which has been drilled, slightly crooked 20—30 metres from the bottom, thus preventing the casing from moving freely, can in most cases be straightened out by screwing together two or three double underreamers with a long sinker bar below and above. It sometimes happens that after a hole has been drilled and cased, the strata creeps slightly in places, necessitating withdrawal of the casing, and as filling up and re-drilling out the hole is a tedious business, the above method of duplicated underreamers has been tried, with excellent results.

Where the formation permits, it is customary to drill from 8—15 metres ahead of the casing shoe and then to underream and case that part off before drilling deeper. Underreaming is a tiresome process, but is very often not given the necessary care and attention, as many drillers consider it to be more or less a waste of time. To drill deep wells successfully, and to carry strings of casing as far as possible, just as much attention must be given to underreaming as to the actual drilling. The following table gives the greatest outside diameter of the standard casings, and the sizes to which

the underreamer dogs should be adjusted for use with the casing given below :—

Casing nominal size.	Greatest outside dia.	Underreamer dogs.
in.	m/m.	m/m.
14 ..	365 ..	385
12 ..	315 ..	335
10 ..	275 ..	295
9 ..	239 ..	257
7 ..	203 ..	220
6 ..	172 ..	188
5 ..	140 ..	155
4 ..	110 ..	125

With shallow holes and comparatively light strings of casing, it is possible to judge, both by the eye and by touch, whether it is going in easily or not. But when manipulating heavy strings weighing from 30—70 tons or more, it is easy to insert a fresh length without noticing the slight jarring motion, as is the case when a lighter string is being let into a tight hole. Sometimes casing, which to all appearances has gone in quite nicely, is found afterwards to have become more or less "frozen" and is only moved with the greatest difficulty. There is also a danger of the shoe length being so badly damaged that it either has to be cut off and drilled up, or the whole column withdrawn, to change the damaged piece. In Galicia, the type of casing used (inserted joint) cannot be driven to any great extent, and the space between any two casing columns is so small that it would not permit the use of a shoe with a shell thickness more than 9—10 m/m. (The ordinary casing wall is 7½ m/m.)

It might be said that "over underreaming" is also not good, especially in territory where the strata is very broken up or one has to deal with finely laminated shales, as caving behind the casing is likely to give much trouble, and might end in the loss of dimension.

Underreamers are seldom used when drilling boreholes from 10 in. upwards; sometimes, when drilling with 9 in. tools; but with the 7 in., 6 in., 5 in. and 4 in. tools, every metre has to be underreamed. Drilling and underreaming is never done simultaneously for the following reasons :—

The underreamer prevents the free throw of the tools and their unhampered free fall.

The weight of the tools is not much more than is necessary to overcome the resistance caused by the underreamer, therefore the effect of the blows of the bit would be considerably reduced.

When underreaming in quickly changing strata, consisting of hard laminated shales interspersed with thin layers of sandstone, the dogs of the underreamer would tend to get hung up on ledges left behind by the bit, and in this case

the effect of the underreamer following the bit would be to loosen large pieces, which might wedge and trap the bit.

Sinkerbars are generally made of mild steel and in one piece. When made of iron, steel pins and boxes are welded on. Weights and measurements are as follows :—

Size of drill.	Sinkerbar collar. m/m.	Length overall. metres.	Approximate weight in kilos.
18 in., 16 in., 14 in.	*160 or 180	.. *3 ..	470–530
16 in., 14 in., 12 in., 10 in. ..	160 „ 180	.. 8 ..	1250
9 in.	140	.. 8 ..	960
7 in.	125	.. 8 ..	770
7 in. & 6 in.	105	.. 8 ..	540
6 in.	90	.. 9 ..	450
5 in.	80	.. 9 ..	350
4 in.	60	.. 9 ..	270

* This is a short sinker used when spudding in.

Size of casing.	Sinkerbar collar. m/m.	Length overall. metres.	Approximate weight in kilos.
6 in. and 7 in.	80	.. 7 ..	270
4 in. „ 5 in.	70	.. 7 ..	210

These latter are sinkers used in conjunction with a "Swab."

When using sinkers of large diameter in the smaller sizes of casing, allowance must be made for passing the necessary fishing instruments in case of accident. It is sometimes the practice to forge down the upper part of the sinker so that an instrument can be passed over.

Nothing is to be gained by using a light sinker, whereas a large diameter heavy sinker possesses several advantages ; the sinkerbar is more rigid, therefore greater concentrated effect, and the casing is not so badly "flogged" as would be the case with one of smaller diameter ; also it is much easier to keep a vertical hole, drilling proceeds quicker, and the chances of breakages, with consequent loss of time and money, are fewer.

Owing to the weakness of the tool joints of the 4 in., 5 in. and 6 in. bits, and the liability of their becoming unscrewed whilst drilling, it is advisable to have the bit welded on to the sinkers ; this eliminates all possibilities of breakages and the chance of a bit, after having broken off, being driven into the side of the hole under the casing, which makes its recovery very difficult. Although not general practice, the swabbing jars are very often welded on to the sinkers.

Jars.—The jars used are of the usual round pattern, and the stroke used for drilling is 25 ctm., for fishing 50—60 ctm. and for swabbing also 50—60 ctm.

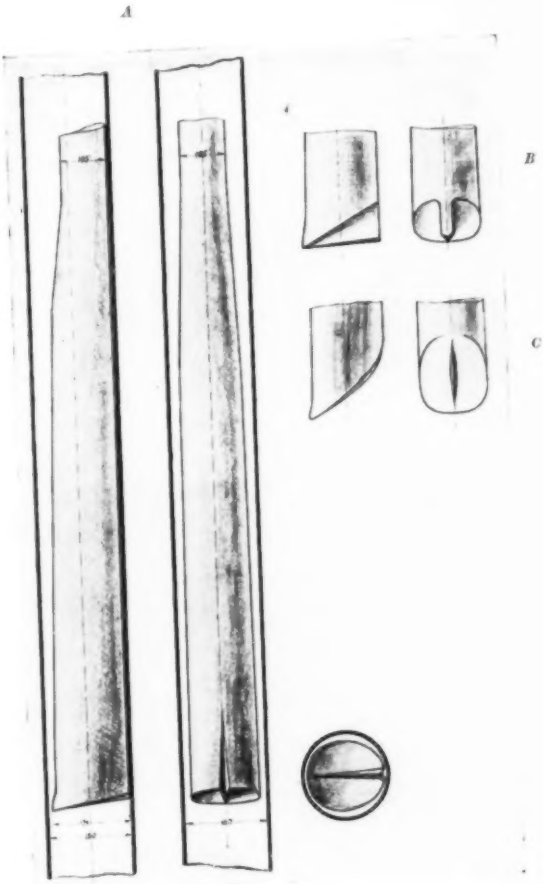


FIG. 4.—HOOF BIT.

A. The bit dressed for straightening out holes which have drilled out of the perpendicular.
B. Dressed for drilling up casing.
C. Dressed for side tracking lost tools or casing.

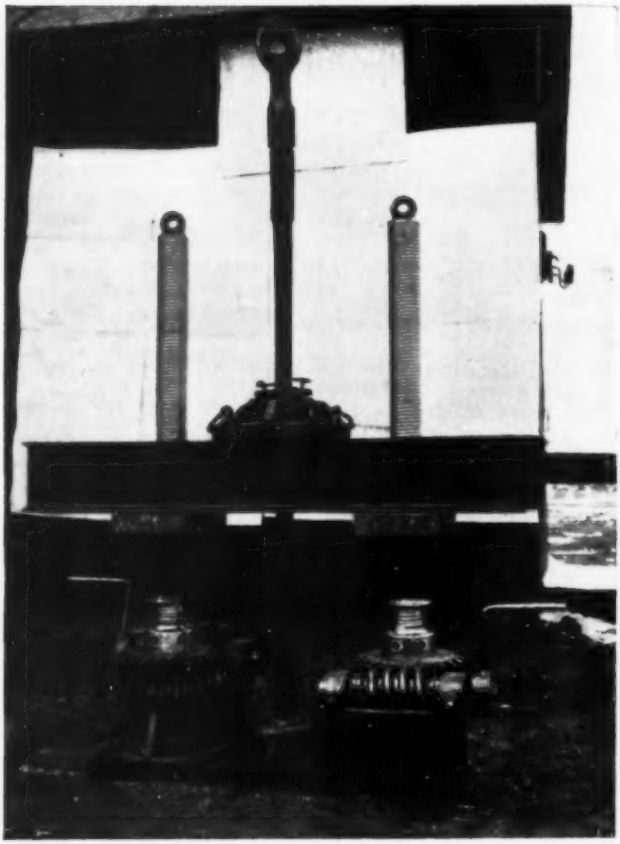


FIG. 5.

A SET OF JACK SCREWS FOR TENSION FISHING.

Substitutes.—These are of the usual type, excepting those sometimes used with heavy tools, which are made with a link movement. The advantage of the latter is, that breakages are less likely to occur than with the rigid pattern, and a good deal of stress is taken off the jars and drilling rods.

Drilling Rods.—When the Canadian system of drilling was first introduced into Galicia, ash and hickory poles were exclusively used, later on, combined strings of ash and iron poles, but as the wells were drilled deeper, and the drilling became increasingly difficult, iron poles entirely superseded the wooden ones. Only rods made of first-class iron are suitable for drilling purposes, some prospectors favour a fibrous iron. Mild steel rods have been tried but proved useless, as they quickly become crystallized and brittle. Iron with a tensile strength of 36-42 klg. per sq. m/m with 20-25 per cent. elongation is the most suitable material. The life of a string of good iron rods, drilling at a depth of 1300-1500 metres, is approximately three months, whereas a string of mild steel rods commence to crystallize and break within the first month ; this is especially the case in caving or sticky formations, when the rods are most severely stressed. It is not unusual when fishing for stuck tools, and much upward jarring is done either from the beam or with the tackle, for iron rods to stretch without breaking as much as from 2 to 3 metres and even more per rod (the rods are 11 metres intitial length) with a reduction of as much as 3 to 5 m/m in diameter, this "give" is a very essential quality.

All rods should be thoroughly annealed before leaving the works, and they should not be laid in a wet place after the pins and boxes have been welded on, but should be cooled off as slowly as possible in order to avoid any chance of local hardening. The very best smithy coal or coke should be used for welding, and of recent years the lack of this commodity has been very severely felt on the Galician oilfields and many badly spiked wells can trace their trouble to inferior welding of the drilling rods.

When a rod breaks during drilling, there is generally very little difficulty in its recovery together with the string of tools, but a rod breaking, either during letting in or pulling out, is a very much more serious matter, as the tools may run away many hundreds of metres. Should the hole be dry, there is every danger of a great deal of worry and trouble being incurred, as well as months of expensive and weary fishing, before the tools are recovered. A good plan is to give the rod men a premium for detecting flawed rods during pulling out or letting in, and it is surprising how expert they become in finding flaws which the inexperienced man would not detect.

Iron drilling rods are made in three sizes :—30 m/m dia. when the well is first started and are kept in use until the well is 300-350 metres

deep, 26 m/m dia. rods are used from 350 to 650 metres, and 22 m/m dia. rods are used for any deeper drilling. All rods are about 11 metres long and weigh without pins and boxes :—

30	m/m.	dia.	..	..	..	..	..	62	kilos	per rod
26	„	„	..	..	..	..	..	46	„	„ „
22	„	„	..	..	..	..	..	35	„	„ „

The time taken to let in 125 rods is about one and a-quarter hours for a well about 1400 m. deep and about one and a-half hours for withdrawal. The pins and boxes used with the 30 and 26 m/m rods are heavier and larger than those used with the 22 m/m rods.

Standardization of Tool Joints.—Galicia is probably worse off in this respect than any other oilfield, and very little has been done towards adopting a standard joint for drilling and fishing tools. There are at present four different types in use, neither possessing any great advantage over the other, there being only a slight difference in either taper, threads per inch or shape of threads; this all tends to confusion and is likely to result in accidents.

Taking into consideration the risk and enormous cost of successfully drilling wells 1300-1700 metres or more, even when first-class plant and tools are used, it is surprising to note how small the effort has been to introduce one standard gauge. There are firms operating on a large scale in different parts of the field, using tools with different types of joints; this is explained by the fact that section foremen or non-practical men, are allowed to order tools, the former order to any gauge they particularly favour, and the latter, not possessing the necessary knowledge, have to leave the matter of gauge to the manufacturer.

As special tools have very often to be borrowed by one section from another, confusion results. Joints have to be hurriedly worked over, or special connections made. Economy combined with maximum efficiency can only be obtained if there is one standard tool joint and when each individual class of tool is made to the same specification, thus rendering all tools interchangeable. It is advisable, however, when possible, to keep each set of tools as an individual unit, as, after a set of tools has been working and the joints have been made and broken several times, the pins and boxes adapt themselves to one another.

Too much force is generally exercised when screwing up tool-joints, which suffer in consequence, as either the threads, pin or box are strained, and this is a frequent cause of fractured pins or burst boxes. With properly made joints, the friction hold which prevents the tools from unscrewing whilst in use should be evenly distributed over the threads, and the bringing of the two collar faces together should be sufficient to lock the joints securely without application of undue force being required. But, as a rule,

too much dependence is put upon the friction hold of the collar faces, and not of the threads. There are two bad practices which cannot be too severely condemned: the first is the use of thin washers between collar faces, when the joints will not pull down face to face, and the second the hammering of joints to facilitate screwing together.

Well-made joints should come together to within one and a half to two and a half m/m without applying chain levers; then they should screw up tightly. Another thing which will strike any careful observer are the haphazard methods used when making and gauging tool joints; the most elementary principles are either disregarded entirely or not understood, and it is not at all an uncommon occurrence to find gauges which have been several years in use considerably worn, with the threads badly strained and their shape lost. If, for instance, a 7 in. drill were ordered to a certain gauge from one works, and a sinker with the same type of joint from another works, one would be more surprised if they did fit and screw up properly, than if they did not. Every company should have a complete set of gauges, and every tool, whether new, or in after repairs, should be carefully gauged as soon as it is taken on to the property or put into the stores. Dimensions of tool joints chiefly used are :—

Nominal size of hole.	Collar. m/m.	Top of pin. m/m.	Base of pin. m/m.	Height of pin. m/m.	Threads per in.
16 in., 16 in., 14 in., 12 in., 10 in. ..	180	100	130	150	6
18 in., 16 in., 14 in., 12 in., 10 in. ..	160	90	115	125	6
10 in., 9 in.	140	72	95	115	6
7 in.	125	65	85	100	6
7 in.	105	55	75	95	6
6 in.	105	55	75	95	6
6 in.	90	50	68	90	6
5 in.	80	45	60	75	6
4 in.	60	30	45	75	7

Maintenance of Plant and Tools.—As in all other branches of engineering, plant and tools should be maintained in first-class order, but in the mining section of the petroleum industry machinery is seldom attended to until there is a breakdown, and is often only fit for the scrapheap when with proper attention it might have lasted many years.

The same thing applies to tools. Very little is done to maintain tools in first-class order, which is absolutely necessary to obtain good and economical results. Rigs are allowed to get out of truth, causing ropes to wind badly, blocks and tackle, through not being periodically overhauled and cleaned, run hard, and help to destroy the ropes. Drilling engines often run until they almost knock themselves to pieces before a repair is effected, and any kind of lubricant is generally considered good enough for drilling plant; in

fact, the whole equipment is more often than not maintained in a most slipshod manner.

The eagerness to get down to oil appears to blind responsible persons to the fact that the cheapest, quickest and safest manner to get there is to treat the enterprise as an engineering proposition, even to the minutest details, as the present method of "anything will do" and absolute lack of system if applied to any other engineering undertaking would spell disaster. Boilers are often not scaled until the tubes are badly leaking, when scale is removed up to ¼ in. thick and more, and no thought has been given to the enormous waste of fuel which has been going on; and where an auxiliary boiler has not been provided, as is often the case, the well has to be shut down whilst the repair is carried out. Lack of foresight in providing casing, tools and other necessary materials well ahead of time is a frequent result of loss of drilling time and money; this is especially the case where wells are situated in out-of-the-way places. What would be the result in a large engineering works if half the machines and men were idle because the supply of a certain material had been overlooked?

Statistics regarding stoppages due to repairs and waiting for materials would be interesting, especially if the monetary losses were calculated, and would do more than anything else to convince the prospector where his "economy" proves to be most extravagant.

All tools should be periodically inspected by a competent man; drills, underreamer-bodies, substitutes and sinker-bars, ought to be annealed at intervals when in constant use. As soon as tools are finished with, they should be annealed, dressed and all joints carefully gauged and brought up to standard before they are stored away.

Fishing Instruments.

Of all tools used when drilling with the Canadian Pole Tool System, fishing tools have the greatest variety, and standardised types are very few. This is accounted for by the fact that hardly any two wells are "spiked" in exactly the same manner, and although there are rules which govern the mode of procedure in every case, still, the strength and construction of the instrument depend on circumstances, and must be adapted to the individual requirements of the well.

The most frequent of all "spikings" is the breaking of rods whilst drilling, and their recovery is seldom difficult. For this purpose a standard tool is made, known as the "universal socket," it being a combination of the tongue and slip sockets; the slips are used when taking hold of a plain rod, but when a rod breaks just above the box, then the tongued portion is used. In cases

where the tools have run away, either during letting in or withdrawing, or where tools have become stuck, it is not advisable to take hold with a bulldog instrument, and in such cases it is better to remove the slips and use the tongue part. If the tools refuse to move, then, with a little upward jarring, the tongue, which is of hardened steel at its edge, shears through the rod and the instrument can be removed. If, for instance, the socket has gripped an object of thicker dimension than a drilling rod, say, at a joint which cannot be sheared through like the rod, then by upward jarring the pin which holds the tongue in its place is sheared, the instrument releases its hold and can be withdrawn.

The "Universal Socket" is one of the most useful and reliable of all fishing instruments; it is made in two sizes, one suitable for use in 5 in. and 6 in. casings, and the other for 7 in. casing and upwards. It is constructed of mild steel throughout, excepting the slips and tongue, which are made of tool steel.

Another very useful socket is that with a single sliding dog, and is employed where it is necessary to loosen up stuck tools by jarring of long duration, also for unscrewing drilling poles.

The Open Socket, either one or two legged, is another instrument which is used when one has to grapple for twisted rods or bent tools. A "Tute" or Taper Die Socket is the most useful and safest of all, and is used for connecting on to tools where the pin has broken off, or for unscrewing tools, drilling rods, etc., and when well screwed on, can also be used for upward or downward jarring when loosening up tools which have become fast in the well. The best taper for this instrument is 2.5 m/m per hundred, and a thread of 8, 9 or 10 per inch is usually cut; the inside of the tool is oil-hardened.

There are two kinds of Casing Swedges, the plain-fluted type or common swedge, which is used when starting to swedge out badly collapsed casing and the improved Roller Swedge. The latter is by far the safest instrument, as it is not likely to become jammed, neither does it wear the casing, and more rapid progress is made than with the common swedge. Both types of swedge are made of mild steel, and the rollers are of tool steel, oil-hardened.

There are many types of Casing Spears, but most of them are uncertain as regards releasing hold when it becomes necessary.

Hooks, Spuds and Rasps are made to suit the work in hand; it would be difficult to make a standardised tool of this description, as their shape depends entirely on the job for which they are intended.

A Standard Rope knife is made, but it is an instrument which is seldom required. There are two types of rope spear—the single

and double wing—the former is more often used, and a plate is fitted just below the collar, of a little smaller dimension than the casing, in order to prevent the spear being driven too deeply into the rope.

Fishing Poles are made in three sizes, 40 m/m, 65 m/m and 70 m/m diameter, the latter being more frequently used. They are made of mild steel, the pins and boxes are not welded on, but form part of the fishing pole; they are 8½ metres total length. The larger diameter fishing poles are only used in extreme cases, such as pulling loose "frozen" strings of casing or fishing for runaway casing. Owing to their great weight, every care has to be exercised when using them, as trouble often occurs when doing so. A string of 70 m/m poles, 1400 metres long, weighs approximately 42 tons; jackscrews are more often used in conjunction with fishing poles than hydraulic jacks, as these are liable to freeze up in wintertime. The 40 m/m poles are generally used for unscrewing drilling poles and other tools, also for jarring, but are seldom used for tension fishing.

When the tool attached to the poles has taken hold, if upward jarring or a direct pull with the tackle has no effect in pulling loose the object to be recovered, the jackscrews are put on and the poles then put in tension, that is, after the weight of the poles has been taken up, jacking is continued until they are stretched from 5–10 centimetres; the poles are then left to recover themselves, the time allowed being anything from 1 to 12 hours, or even more, according to circumstances. This operation is repeated time after time, until the object has been freed, or if unsuccessful, another method has to be tried.

Fishing of the above character may take days or even months, and it is not unusual to hear that the fishing poles have been stretched over a period of one to two months as much as fourteen metres and more. Tension fishing requires a great deal of skill and patience; if the rods are stretched too quickly, and not given a fair chance of recovering themselves, breakage is almost certain to occur, and the recoil of the heavy rods will render an already difficult fishing scrape almost hopeless, and, at the very best, will greatly prolong its duration with the attendant expense and worry.

Another very useful standard fishing tool is the Impression Socket, which is used for taking impressions of lost tools, etc. It is a most necessary instrument and cannot be employed too often during fishing operations. The bowl is usually filled with wax, and with this the impressions are taken. This implement stands in relation to the driller as does a stick to a blind man.

The most usual difficult fishing jobs met with when drilling with the Canadian Pole Tool System are as follows :—

(*a*) Runaway strings of casing, when the casing is not only torn into strips, but also telescoped as much as three or four lengths, one inside the other, As an instance of this, 1200 metres of 5 in. casing ran away ten metres, the piece of casing which was held in the clamps and was originally above the level of the derrick floor was located 90 odd metres deeper.

(*b*) Tools with several hundred metres of rods, which have run away anything up to 1000 metres and more, the tools becoming bent and the rods breaking off time after time, twisting and bending themselves into all kinds of inconceivable shapes.

(*c*) Broken off tools which have been drilled upon and been driven under the casing often give much trouble, especially if the formation happens to be very hard and does not permit side-tracking.

(*d*) Runaway tools which have carried several hundred metres of casing with them generally forms a very difficult fishing scrape.

It is not always the original accident which proves fatal in a well, but complications ensuing either through mishandling or lack of foresight ; very often the driller is a great deal to blame through giving inaccurate information as to how the spiking actually occurred, resulting in a simple fishing job turning into a difficult and prolonged operation, and sometimes even in the abandonment of a well.

If it is expected that the fishing job is liable to become complicated, as is the case with runaway casing, tools, etc., no instrument should be let down the borehole before accurate measurements have been taken to ascertain the exact depth at which the casing or tools lie. Whenever possible the well should be measured by rods and not with a rope ; an impression block, on to which a pair of jars and above them a sinker has been connected, is coupled on to the rods, by this means there is the advantage of measuring up the hole and taking an impression of the lost tools or casing at the same time. The impression block should only be a fraction smaller in diameter than the inside dimension of the casing, and it should be seen that tools for fishing are connected in the above manner, as careless drillers sometimes couple up the tools as for drilling, *i.e.*, the jars above the sinker, whereas the jars should be *below*, so that in case a tool becomes trapped, it can be jarred free again.

The first tool used for taking hold should be so constructed that it can be easily disconnected from the tools being fished for whenever required. In a case where a number of rods have run away with the tools and cannot be recovered, either because the bit has become bent, or, what is more likely, the jars have opened out instead of jarring upwards, which will probably end in further breakages, the rods should be unscrewed. Three tools can be used for this purpose, the ordinary socket, the single sliding wedge socket or a taper die socket, the latter is the most reliable instrument, as it can always be screwed on or unscrewed at will. After the rods have all been unscrewed a direct connection can be made on to the tools, when the condition of the lost jars can be ascertained; should they move freely, upward jarring can be tried; should the tools not be freed, then the jars should be uncoupled from the sinker, if any difficulty is experienced in accomplishing this, a little upward and downward jarring will generally loosen up the joints and they can then be easily uncoupled. As soon as the jars have been extracted a connection should be made with the "taper die socket" on to the sinker; after this has been withdrawn there is only the bit to be dealt with.

The advantage of unscrewing the bent tools one by one is that as a unit their recovery would be difficult, perhaps even impossible, but by uncoupling them one after another they can be removed. Premature jarring out of bent tools may result in their becoming so tightly wedged in the casing, that the latter has to be withdrawn together with the tools, which is both a tedious and risky operation, or the casing may be badly damaged by the bent tools being forced through.

In addition to accurate measurements being kept as to the depths where the lost tools or casing lie, detailed measurements should be kept of any fishing tool let down, so that in case one is left behind by accident the new situation can be accurately dealt with. It is good practice to measure and trammel the fishing rŏds or poles in order to ascertain any permanent stretch which may have taken place.

A good method to loosen up casing which has become "frozen" is to let in tubing, which has been connected up to the steamline into the well, and then to steam the casing for any time up to 24 hours. The effects of this procedure are :—

(*a*) The casing is expanded circumferentially, and the cavings or other matter behind the casing is forced back so that when the casing contracts on cooling down a free space is left between it and the walls of the borehole sufficient to allow it to be moved.

FIG. 6.

5" CASING FISHED OUT FROM A DEPTH OF 1000 METRES ; IT WILL BE SEEN THAT THREE OR FOUR PIECES WERE TELESCOPED ONE INSIDE THE OTHER.

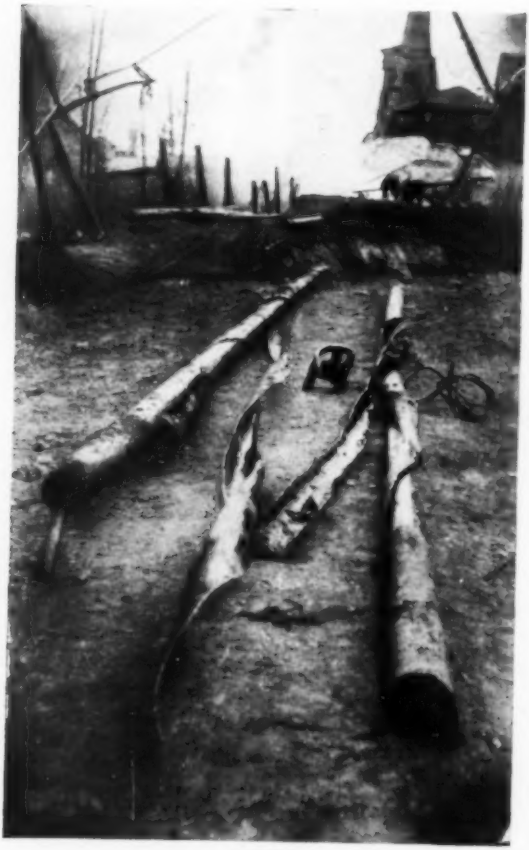


FIG. 7.

5″ STEEL CASING FISHED OUT FROM A DEPTH OF 1150 METRES. TO THE RIGHT A KNOTTED DRILLING POLE IS TO BE SEEN, WHICH WAS ALSO FISHED OUT.

(*b*) An accumulation of paraffin wax behind the casing will very often cause it to stick, it can be easily freed by the above method.

(*c*) Another effect of the heating is to expand the column along its axis (length). During this process the weight of the casing should be taken by the tackle.

(*d*) After it is considered that the casing has become sufficiently expanded, the casing dogs (clamps) are replaced, steam shut off, and the pull exerted by the contraction when cooling down generally gives the desired results.

When freeing casing by this last method, one must take care that it is not "over expanded," otherwise it is liable to tear apart on cooling down.

Jarring.—Jarring loose is one of those simple operations which through mishandling and want of thought are often the cause of serious complications. A few hundred blows with tools of the right weight will nearly always have the desired effect, whereas many days of jarring with tools of insufficient weight generally ends in the breaking off of drilling rods, sinker bar or jars, owing to their becoming crystallised.

After all rods have been extracted and the hole is so far clear that a direct connection can be made on to the lost tools, the "jarring" bar can be lowered in; the weight of this should be at least three times that of the lost tools to be recovered, otherwise the jarring will have no effect. It is quite a common occurrence to see drillers trying to jar a tool loose, using a jarring bar weighing one-third less than the tools he is trying to free, and one frequently hears it remarked that jarring has been done for days until the pin had been jarred off the sinker, or until the sinker had broken in two, and still the tools refused to budge. The driller is under the belief that the effect of his jarring has been tremendous, but in reality it has only had one effect, that of crystallising the upper part of the lost sinker, and the bit has not felt the effect of the blows delivered at all.

Frozen casing is seldom loosened up by jarring in Galicia, but when this method is resorted to, the casing must be first put in "tension."

All fishing jobs call for great care and foresight combined with skill and ingenuity and an unlimited amount of patience. Undue haste and loss of patience is almost always fatal to the achievement of satisfactory results.

Casings.

It is usual practice to start the wells with 18 in. or 16 in. riveted casing, made of 5 or 6 m/m sheet iron, after the hand-dug well from 5 to 10 metres deep, which is lined with wood, has been com-

pleted. The 18 in. riveted casing is carried down to 15 metres, and the 16 in. to 25 metres or more.

All other casing used is made of steel, welded or solid drawn inserted joint type (left hand threads), standard casing is of the following dimensions :—

Nominal size. in.	Outside dia. m/m.	Inside dia. m/m.	Thickness m/m.	mtr.	Weight per klgs.	Depth to which usually taken.	Total weight of column in met. tons.
14	355	337	9	81·2	120	9·5
12	305	289	8	61·9	400	24
10	267	253	7	47·4	600	28
9	231	217	7	40·5	1000	40·5
7	195	181	7	34·2	1350	46
6	163	148	7·5	30·2	1650	51
5	132	118	7	22·7	(up to 1800 or more)	45
4	102	88	7	17·2	this is no longer a regular casing and only used as a last resource.	

Top waters are shut off with the 14 in., 12 in. and 10 in. casings. Extra heavy types of casing will weigh 25 to 30% more than the weights mentioned above, which are for normal types.

The depths to which the 7 in., 6 in. and 5 in. casings are taken, depends whether any deep water has to be shut off, or at what depth production is struck If the casing is kept moving until the oil sand is exhausted, drilling can be continued with the same string.

6 in. and 5 in. casings are known as swabbing strings, and special care is taken by the manufacturers to ensure a smooth finish being given to the inside. A string of swabbing casing on the Boryslaw-Tustanowice-Mraznica field will last from 5–7 years, with continuous swabbing, that is, if the hole is perfectly straight, but after it has been in use for about three years it is advisable to withdraw the casing for examination.

The material from which the lap or patent welded casing is made has a tensile strength of 35–40 kilogrs., and elongation of 25 per cent.; the solid drawn steel casing has a tensile strength of 55 to 65 klgs., and from 11 to 16 per cent. elongation.

Casing with a tensile strength of 60 to 65 klgs. and 12 per cent. elongation gives most satisfaction, as it is not easily dented or dis-formed by rock pressure, and at the same time is not brittle.

The attention given to casing during its insertion, or to the maintenance of a free string, is often very lax, and as a rule too much force is exerted when screwing it together, and no account is taken of the stress put upon the joints. The usual method when adding a fresh length is to screw it into the previous piece until it will not screw in any farther (ten to twelve men are often used for the purpose of screwing up) and when the male portion will not screw in to the required amount, extra force is applied, regardless

of the stress being put upon the female joint, which is very severe and often results in it becoming strained. It must be borne in mind that a joint may be carrying from 40 to 60 tons and should an extra sudden load be put upon this already strained joint, as when casing is being lowered in and is caught suddenly in the casing clamps (a frequent occurrence with careless drillers), the joint is liable to burst, dropping the whole string. The bad practice of hammering the joints during screwing in should be strictly forbidden; if a joint will not screw up it should be gauged to ascertain where the fault lies.

Free strings of casing should be given continual attention, especially in deep wells where the column weighs many tons, as, for instance, swabbing wells, where once the casing has been let in, it remains there for three years or more. The top piece should be accurately trammelled, and the trammel kept for future control. Prospectors endeavour to keep their casing movable so that when the horizon being exploited has become exhausted drilling can be continued with the same dimension. It is necessary to move the casing at regular intervals, from once a week or more often to once a month, depending on the well.

Every time the casing is moved it is subject to three distinct shocks, firstly when the casing is lifted, and the load is the casing column plus ground friction, which may be many tons; secondly, when it is being lowered into its place, its downward movement is suddenly checked by the casing dogs gripping, and thirdly, when the driller lifts the casing and clamp plate together, from one to two feet, and then lowers sharply into its place in order to make sure that the dogs have taken proper hold and the casing cannot slip through. The load imparted to the top piece of casing when a column weighing from 40–60 tons is brought to an abrupt standstill is very great, and after this operation has been repeated for several months it is liable to become slightly stretched; this stretch in time remains permanent, therefore the necessity for trammelling the top piece of casing. This is especially necessary in Galicia, where the standard casing has only a shell thickness of from 7–7½ m/m, liable to a variation of plus, minus 1/2 to 1 m/m, due to insufficient care being taken when rolling.

When manufacturing casing, very often sufficient trouble is not taken to see that the joints are turned and threaded concentrically, and if a control gauge is used it will be sometimes found that the joints are turned and threaded eccentrically. Heavy type casing with a shell thickness of 8–11 m/m is gradually superseding the standard type hitherto used, which proved unsuitable for very deep wells and the changed drilling conditions of the southern part of the Boryslaw-Tustanowice-Mraznica field.

Drilling.

The ordinary winged bit is used for spudding in.

The bit with a short sinkerbar 3 metres long, weighing from 450 to 500 kilos., together with the jars are coupled on to the walking beam, that is, if the depth of the hand-dug shaft allows, if not spudding in is done on the tool line.

The winged bit is only used as long as the rivetted casing is being put in, which is generally to a depth of 25 metres, as soon as the hermetical casing is used the eccentric bit is practically the only type employed.

Drilling in the miocene series presents no particular difficulties as long as the borehole is kept full of water. The top water is shut off in the clays of this series. These clays are sometimes very sticky and give a great deal of trouble; a good remedy is to put in a quantity of brick or soft sandstone and to drill it up with the clay.

The upper and lower oligocene formations give more trouble owing to the shales caving badly; thin layers of sandstone and hornstein cause the hole to go crooked if the drilling is not very carefully watched. Should the wear of the bit point to the fact that one side of the hole is soft and the other hard, it is advisable to immediately put in a filling of hard rock or cast iron and to slowly drill same up. It may be necessary to repeat this operation several times before a well (properly) worn bit is withdrawn.

Should the above method not prove efficacious by means of the eccentric bit, or, if several metres of the borehole have been drilled crooked, fillings as before mentioned should be put in and the eccentric bit replaced by a hoof bit. One or two fillings slowly worked out by this type of tool will usually straighten out even the most crooked hole.

The fillings are let into the hole in canisters made of thin sheet iron, a little smaller in diameter than the casing and about one metre long. Steel wire rope cut in lengths of from 6 in. to 8 in. makes a good filling. Special care must be taken to see that the hole is properly under-reamed when drilling in the lower oligocene; in fact, too great attention cannot be paid to this part of the work.

Another way to straighten out a crooked hole is to let in one or two lengths of casing (depending, of course, on how much of the hole it is necessary to straighten out) one or two sizes smaller than that in use, this can either be drilled up or sidetracked, and in obstinate cases often proves to be the quicker method of the two.

In some parts of the Boryslaw-Tustanowice-Mraznica field, black sticky clay is found just overlaying the Boryslaw sandstone which is apt to give a good deal of trouble. It is practically impossible to pull or jar loose a tool which has become embedded

in it, even if to the extent of only a few centimetres. There are many cases where tools have become suddenly stuck fast, and although 70 m/m diameter fishing poles have been used with fishing screws (jack screws), and the force exerted was sufficient to stretch these poles more than 12 metres (total length 1100 metres), the embedded tool remained fast. Upward jarring of long duration had no better effect. In such cases there only remains one course to be taken, that is to loosen up by drilling alongside. This course should only be adopted after every drop of water has been removed from the borehole and been replaced by oil; if this is not done, in all probability a second set of tools will also get stuck.

When the Boryslaw sandstone is struck, it is easily recognised by the whiteness of the sand brought up in the bailer, also by the appearance of the bit, which has very sharp cutting edges, or what is known as a "wire edge." Precaution has to be taken not to pass even the slightest gas or oil show, and it is worth while, after having penetrated the sand for a few metres, to suspend drilling operations and carry out a good swabbing test. Should there be no results, drilling must, of course, be continued, and another test made every two or three metres, as it is very easy to drill past the oil in this formation. It is also advisable to underream this sandstone to the maximum extent the casing will allow.

The foregoing applies to drilling in the Boryslaw-Tustanowice-Mraznica field, but in other parts of Galicia, where shallow wells are chiefly sunk, and where the sandstones are generally not very thick, still greater care has to be taken. As soon as the detritus shows signs that oil should not be far distant, as, for instance, brown or black shale, which, when broken up shows oil traces, or if, when the sandpump is withdrawn from the borehole the detritus is gassed, or there are gas shows, all water in the borehole should be carefully removed, only using that necessary for mixing the detritus. When shows are met with in sandstone, the well should be underreamed and thoroughly pumped out, or a swabbing trial made if the casing dimension allows.

Great care has to be exercised when drilling in the eocene series, owing to the caving shales and thin layers of sandstone, which often slide partly across the borehole upon the tools being withdrawn. If it is found that one has to deal with a moving sandstone of this description, on no account should the casing be forced by, but the hole should be filled up again and again until the layer no longer moves, otherwise trouble will ensue.

Water is seldom met with in the lower oligocene series in the Boryslaw-Tustanowice section of the field, but is found in Mraznica in large quantities. Small shows of salt water are always met with in the eocene series, and occasionally in large quantities under

considerable head, either just before striking the oil sandstone or just after it has been passed. Water is generally shut off in the following manner: After a seating has been made in which to set the casing shoe, a filling or plugging of clay containing practically no sand, is put in. During this process the casing is slowly withdrawn, until from 15 to 20 metres from the bottom of the borehole has been plugged, the casing is then forced down through the clay until it reaches the prepared seat. The well is then left for a few days before the work is recommenced.

Drilling in the Carpathian overthrust presents the greatest difficulties. In the first place the beds of sand or quartzrock are very steep, and their hardness, combined with a tendency of the hole to go crooked, renders progress very slow; it is impossible to run a bit for more than from 10 to 20 minutes, when it has to be withdrawn for re-dressing. Secondly, boulders of all sizes are embedded in the soft shales and clays and give great trouble, as they move about under the blows of the bit, and it often takes many hours, and sometimes even days, to shatter or drill past these obstacles. It is imperative the casing should be kept as near the bottom of the hole as possible, otherwise the caving of the clay and shale and fragments of rock may trap the tools and make their removal a difficult operation. It is also advisable not to lift the casing any distance, as the walls of the borehole cave immediately, forming a cavity; from this increased area the tendency to cave becomes more serious. When once this happens, it becomes almost an impossibility to either drill or get the casing down.

When drilling through the overthrust, casing seldom goes in easily, and being inserted joint, neither can it be driven, and the only method which is successful, when letting in a fresh piece of casing, is to lift the column not more than from 6 in. to 8 in. and then to let it in by its own weight; the progress during each lift and release, may be anything from 1 in. to 2 in. up to a foot or more, so that it often takes hours to let in a length.

The 400-700 metres (depending on which part of the field the borehole is located) of the overthrust, may take months of hard work to drill through, and taxes the patience of even the best and most experienced driller. It is useless trying to shut off water in the overthrust, because, if one is successful in shutting off one water, another is met with a few metres deeper; therefore it is necessary to leave in the 12 in. and 14 in. casings, which are casing off the formation of the thrust, and to shut off water with the 10 in. or 9 in. at about 50 to 70 metres below the point of contact of the thrust with the regular Boryslaw series.

The type of casing at present in use fully meets the requirements of the eastern and western Galician oilfields, but it is not suitable

for drilling in south Tustanowice and Mraznica, which districts are now being energetically opened up, as it was originally designed for the comparatively easy drilling in the northern and middle section of the Boryslaw and Tustanowice field, where columns of water from 50 to 1000 metres and sometimes more had not to be shut off. There is only one remedy possible, and that is a completely new design of casing will have to be adopted. Another point to which attention should be given is the sandpumping out of the well of all fluids before setting a string of casing which has no water to shut off. Such neglect has undoubtedly been the cause of several bad experiences of collapsed casing. It is often necessary to keep a full hole of mud-laden fluid while drilling, in order to prevent the walls of the borehole from caving, but as soon as it is decided to set the casing, the whole of the fluid should be slowly removed, so that a large column does not remain trapped behind the casing after it has been set.

At the time of writing there are over 20 wells with one or more columns of collapsed casing, at depths ranging from 600 to 1500 metres, owing to the casing not being strong enough to withstand the pressure. It is thought by some oilmen the cause of this is chiefly due to lateral movement of the formation. This theory may be, to a certain extent, correct where the casing which has collapsed has been casing off the formation composing the Boryslaw overthrust, but where, as in some instances, the collapsed casing is that casing off the "Dobrotower" formation, which composes part of the regular Boryslaw series, at a depth of from 400–500 metres below its contact with the overthrust, in all probability the cause of the trouble arises from an entirely different source, namely the trapping of a column of water which has been kept in the borehole to facilitate drilling. Oil shows in any quantity met with during drilling could also produce the same effect, and in cases where the casing column shutting these off is not at the same time shutting off water it is advisable to perforate the casing in several places, both below and above the depth at which oil was found. A recent case is of interest. The water was shut off with 10 in. casing at approximately 500 metres; 9 in. casing was then let in and carried down to nearly 900 metres, no fresh water being met with. 7 in. casing was then let in and drilling was continued to nearly 1000 metres, when strong gas was encountered. During the whole time a more or less full hole was kept, in order to prevent caving, but when the gas was struck, it lifted this column of fluid up several hundred metres, with the result that it was suddenly found—they were drilling at the time—that the tools had become stuck, and all efforts to remove them were unavailing. The drilling rods were then unscrewed as far as possible, and a casing gauge

was lowered in, when it was discovered that the 7 in. casing had collapsed completely, and later on it was ascertained that the 9 in. had also been crushed. At first it was thought that the water shut off behind the 10 in. casing had broken through, but after having bailed out a quantity of mud-laden fluid, no further influx was detected, which was sufficient proof that the water shut off behind the 10 in. casing had not broken through. This all points to the fact that the column of fluid shut off behind the 9 in. casing was the cause of the trouble; as long as the borehole was kept full of liquid nothing occurred, but as soon as the gas lifted, and emptied in one rush this fluid out of the inside of the casing, the pressure on the outside walls of the 9 in. casing became too great, and it consequently gave way under the strain, crushing at the same time the 7 in. This well was faced with months of tedious fishing and work to drill past the collapsed casing and drilling tools.

Another very probable cause of collapsed casing is gas shut off behind it after it has been set. It is not the large quantity of gas which is dangerous, as this is noticed by the drillers, and provision can be made to allow for its escape, but rather the small quantities, which come under the heading of gas shows; these are frequently encountered during drilling, their volume is not great, but often under considerable pressure, when free egress is barred. After the casing has been set, should cavings form a bridge above such a gas show, sealing it up, there is always a danger, when the gas has accumulated and reached its maximum pressure, of the casing suddenly collapsing when unsupported from the inside.

When drilling, great attention must be given to the taking of samples of all strata passed through; a specimen should be taken from every sand-pump of detritus removed from the borehole, as well as from any found adhering to the bit when withdrawn. These selections should be labelled and kept, and special care taken to discriminate between the strata being actually drilled in and cavings. The writer has found it good practice to keep samples of every 1 to 3 metres drilled, except where thick beds of sand, shales or clays are met with, and then of every 5 or 6 metres.

Some very quick drilling has been accomplished by the Canadian pole tool system, as the following examples show:—

In Tustanowice a very usual performance was from 800 to 1000 metres in from five to seven months with either 7 in. or 9 in. casing. 1200 to 1300 metres took from 14 to 16 months, ending up with either 5 in. or 6 in. casing. Formation: miocene clays, upper and lower oligocene, laminated shales, clays, hard and soft sandstones.

In some places in western Galicia five hundred metres have been drilled in from 7 to 12 weeks. Formation: Lower oligocene,

FIG. 8.

SOME KNOTTED PIECES OF 22MM. DRILLING POLES FISHED FROM A 6″ HOLE FROM A DEPTH OF 1300 METRES.

FIG. 9.

A KNOTTED 22MM. DRILLING POLE FISHED UP THROUGH 6″ CASING FROM A DEPTH OF 1385 METRES.

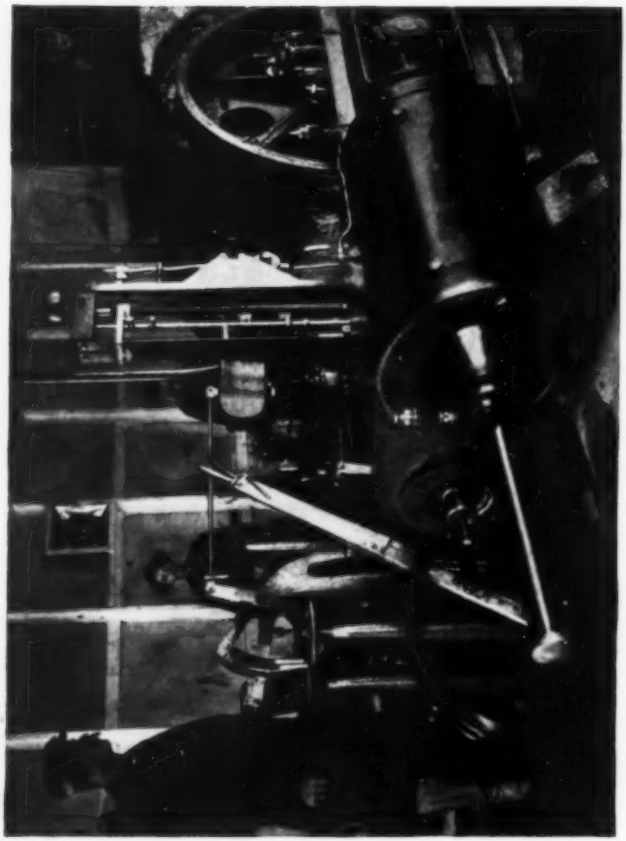


FIG. 10.

A LARGE WINDING SET. (SWABBING PLANT.)

laminated shales, sticky clays and sandrock. In formation consisting of shales, clays and soft sandstones from 10 to 20 metres can be drilled and cased in 24 hours, *i.e.*, if the beds are not dipping very steeply.

Drilling by the Canadian Pole Tool System is not so easy as it is sometimes thought, that is, if good and quick results are to be obtained, and long training is required before a man can competently handle his tools to suit the various formations encountered during drilling. The chief aim to be attained is the correct throwing of the tools, that is, the tools are not lifted, but are thrown up and allowed to fall freely, thus obtaining the full benefit of the weight of the tools when striking, plus the distance through which they fall. By drilling in this manner, the detritus is well mixed with the water, in the hole ; when drilling in clays this is very essential.

In many cases, the failure of the Canadian system to make satisfactory progress is not the fault of the system, but the manner in which it is being handled ; one often sees the bit being run, in such a way that it is practically only being lifted and lowered, or it is being thrown too much, with the result that the bottom link of the jars strikes the top link, falls back, and the jars again come in contact, thus breaking the free fall of the tools.

Power required when drilling.—When drilling a deep well the power required varies with the depth, speed at which the tools are being run, and the strata being drilled through. It is approximately as follows :—

Depth in meters.	Countershaft revs. per min.	Stroke of walking beam in m/m.	Approximate h.p. required.
250	70–75	500	30
400	60	500	30
600	50–55	400	22
700	45–50	400	18
850	40–45	400	14
1000	35–40	370	12
1400	30–35	370	13

Maximum h.p. required for steady drilling never exceeds 45
Mean h.p. „ „ „ „ „ „ 20–25
Maximum h.p. „ „ rod pulling (1400 metre well) 80
Mean h.p. „ „ „ „ „ „ „ 30–35
Maximum h.p. „ „ sandpumping „ „ „ 85–90
Mean „ „ „ „ „ „ 45
Maximum h.p. peak load, required over short periods as when lifting heavy strings of casing, fishing poles, etc. 100–120
Maximum revs. per min. made by drilling engine (steam) is from .. 200–250

When underreaming, the speed at which the tools are worked is less than those given above.

Producing.

There are three means by which oil is produced in Galicia—flowing wells, raising the oil by means of deep-well pumps, and

swabbing. In eastern and western Galicia, where the oil is obtained from shallow wells up to 800 metres, deep-well pumps are used, and a number of wells are connected up to a "pumping rig" or "power." These are generally driven by a gas engine; individual pumping powers, either gas engine or electrically driven, for single wells have not yet been adopted. For wells over 800 metres deep the swab is employed, the use of a bailer being excluded owing to the diameter of the casings, and this method is more or less confined to the B.T.M. field, where the wells vary in depth from 1000 to 1800 metres or more. The swab is nothing more than a plunger fitted with a ball valve, and its working barrel is the casing column. A rubber ring is used as a packing and is kept expanded tightly in the casing by two helical springs, thus any variation in the inside diameter of the casing, as for instance at the joints, as well as the wear of the packing rings, is taken up. These rubber packing rings will last from ten to twenty days or even longer, and assuming a well to be 1200 metres deep, it will have covered from 5,000,000 to 10,000,000 lineal metres and have lifted anything from 800 to 1200 tons of oil. Rings made containing from 50 to 60 per cent. of pure rubber give the best results, but the softness or hardness of the rubber used depends entirely on the well casing and the dirt or sand contained in the oil produced. The swab has a suction effect on the well, and with fast running on the upward journey an average vacuum of 8 lb. can be obtained, and its influence on the well is very beneficial. Producing by means of swabbing is very successful in deep wells having small diameter casings, but only when the oil being produced is derived from compact sandstones, from fissures where the oil channels are liable to become choked, either by sand or paraffin wax; but where the oil is produced from loose beds the use of the swab would be anything but beneficial. In cases where wells have stopped flowing, or in others, where wells have been bailed or pumped, and have practically ceased to produce, a new lease of life can very often be given them by employing the swab discriminately. Of all systems of producing by mechanical means, swabbing is the most expensive. The swab came into being many years ago, but in a much cruder form than by which it is known to-day. When wells stopped flowing, and were too deep for the use of deep-well pumps, operators had recourse to bailing, but only very small quantities of oil could be brought to the surface by this method owing to the small dimension of the borehole (generally 5 in. or 6 in.). One enterprising prospector, whose name has not been recorded, got the idea of wrapping manilla round his bailer, in order to render it more or less a tight fit in the casing; this was lowered into the fluid and the column above the bailer was then hauled up. From

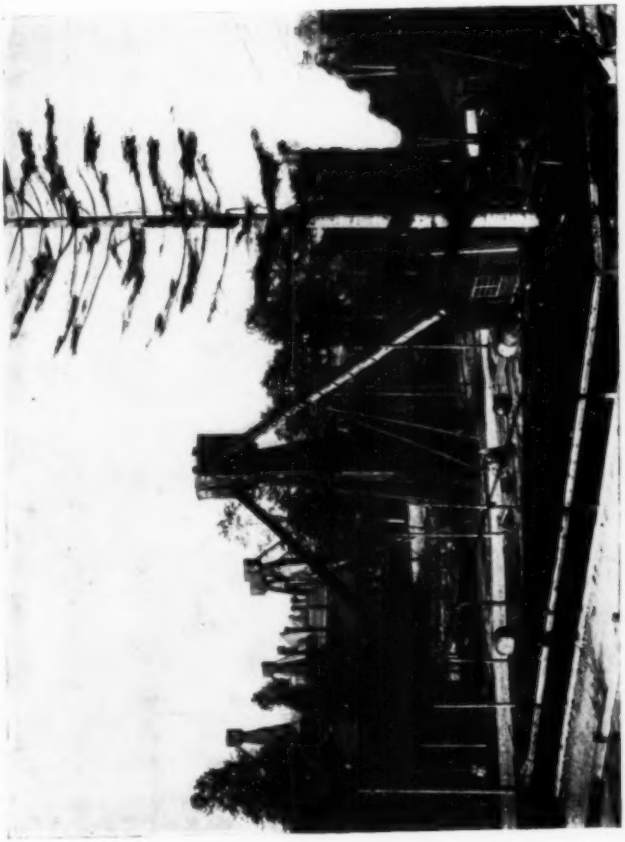


FIG. 11.

A SWABBING WELL WITH DUPLICATED WINDING SETS. NOTE THE WIRE ROPE SHEDDINGS LEADING TO DERRICK HEAD.

FIG. 12.

THE TWO ROTARY RIGS REFERRED TO ARE SHOWN IN COURSE OF CONSTRUCTION IN TUSPANOWICE.

this very rough-and-ready method the present-day swab and means of producing is the result.

A swabbing set consists of the swab, to which is connected a pair of jars, having a movement of from 30—35 cm., and above the jars a sinker bar. The weight of the latter varies according to the diameter of the borehole, and is in turn connected to the bailer line by a swivel fitted with ball-bearings.

Useful Points on Swabbing.

1. The shoe of the casing column should be " bell-mouthed " to allow for the easy entry of the swab.
2. The casing shoe should not be more than 3 to 5 metres from the bottom of the borehole.
3. The rubber packing ring should be expanded about 5 mm. larger in diameter than the inside diameter of the casing.
4. The swab should be run slowly into and through the oil column on the downward journey; otherwise back pressure is put on the oil sand, and in addition the rope is damaged.
5. The swab should be allowed to run below the casing shoe, so as to permit a free influx of oil into the casing.
6. Allow the swab to remain from half to two minutes below the casing shoe before the upward journey is commenced, as this gives the oil plenty of time to collect, especially if the well happens to be sluggish.
7. In cases where the formation allows five to ten seconds after starting the upward journey, the speed of the swab should be rapidly increased, until the maximum is reached, slowing down only at about 100 metres from the top of borehole.
8. Withdraw swab from the casing only when necessary to control rubber packings, as by pulling the swab clear of the casing the vacuum is at once broken.

The speed at which the swab is run depends on the following :—

Depth of well and diameter of casing.
Quantity of oil being produced.
Porosity of producing bed.
Quantity of paraffin wax contained in the crude.
Amount of sand in suspension.
Looseness of producing bed and tendency to cave.

As is the case with pumping and bailing wells, those being swabbed have to receive individual attention in order to ascertain which speed and number of runs per hour is required to obtain the maximum production.

Winding Plant.—The winding engines are double-cylinder, direct-acting, and are made in two sizes, 120 h.-p. and 300 h.-p. The former type is mostly used, the larger engines only being erected on wells giving big productions, the dimensions of the cylinders and winding drum of the two types of which are as follows :—

Small Winding Sets.	120 h.p.	Large Winding Sets.	300 h.p.
Dia. of cylinder ..	350 m/m.	Dia. of cylinder ..	400 m/m.
Length of stroke ..	500 m/m.	Length of stroke ..	600 m/m.
Dia. of drum	1000 m/m.	Dia. of drum	1600 m/m.
Width of drum ..	800 m/m.	Width of drum	700–750 m/m.

In the smaller size ordinary "D" valves are used with Stephenson's valve gear, the point of cut off is a fixed one, and varies from 60 to 70 per cent. of the stroke. This is not economical, and although valve gears have been used by which the cut off could be regulated by the man in charge, they were eventually discarded, as the men only made use of it when under constant supervision. The engines are reversible and non-condensing. The winding drums are fitted with two brake rings and brakes, the latter being copper sheathed, and these are operated both by hand wheel and foot pedal. These brakes are only for emergency use ; on the downward journey of the swab or sandpump the engines are pulled round by the weight of the descending tools and rope, and steam is not admitted to the cylinders, but the air which is sucked in is throttled at the outlet, thus converting the engines into compressors. It is very important that a small quantity of steam should be by-passed into the cylinders by way of the exhaust to keep the air moist, especially where cylinder oils of doubtful quality have to be used, to avoid the danger of internal explosion.

The winding drum is driven direct—that is, keyed on to the crank shaft. A depth gauge fitted with a gong and four striking gears is connected to each winding set, and these are so arranged as to give a signal when the swab is 100 metres from the top when ascending, or the bottom of the borehole when descending. The gong gives a second warning when the swab has reached the limit for which it is set. In the larger sets piston valves are used with Stephenson's link gear, and the cut off is adjustable, so that greater economy is possible, and these valves are more satisfactory than the ordinary "D" valve. Brake rings are fitted on both sides of the drum as in the smaller sets, and the brake can be operated either by hand or by steam power. The maximum speed of the larger winding set is from 80 to 110 revolutions per minute, and that of the smaller type is anything up to 220 revolutions per minute.

The power required for swabbing wells varies greatly and depends on the depth of the well, size of casing, and amount of oil to be

lifted to the top. A 1400 metre well can be taken as an example :—Size of casing 6 in., quantity of oil lifted at each run being 200 klgs. The maximum power required is at about 1100 metres, when the average speed of the rope is from 9—10 metres per second, the engine output then being 250 h.-p. The minimum power required is about 50 h.-p., this being when the swab is approximately 100 metres from the top. The mean engine output throughout the lift is about 180 h.-p., and the time taken to lift the swab 1400 metres is on the average three minutes, the time taken for the swab to descend 1400 metres averages 3½ minutes. These times are sometimes cut down to 2½ and 3 minutes respectively.

Swabbing Rope and Sandline.—These are of usual construction, left hand lay, 18½ m/m diameter, having six strands over a hempen core, each strand containing 19 wires, and are made in any length up to 2000 metres. The swabbing rope has probably to endure more hard work and mishandling than any other part of the drilling or producing plant ; the speeds at which it has to run are very high, often excessive ; for instance, when lifting and lowering in the speed is from 1500 to 1800 ft. per minute, including starting and stopping, and during the fastest part of the run the speed of the the rope often exceeds 2500 ft. per minute.

When the swab is descending care should be exercised to ease off the speed so as to enable the swab to enter the oil slowly, but this is seldom carried out in practice, consequently, when the swab strikes the oil, its speed is considerably decreased, but not so that of the rope, which has to adapt itself by coiling up in the casing, causing considerable damage and shortening the life of both rope and casing.

But this is not nearly as detrimental as the stress which is put on the rope on the upward journey with its load. When the swab has reached the bottom of the well it is generally allowed to stand from one half to two minutes, in order to allow the oil to flow freely into the casing ; then the upward journey commences. From within 15 to 25 seconds of commencing the upward journey, the ropes have generally attained a speed of between 1500 and 2000 ft. per minute, and this is increased up to 2500 ft. per minute. It is quite certain that at the start the rope is stretched very considerably before the swab is set in motion, not with a gradual increase of speed, but with a sudden jerk which is caused by the pull of the winding winch, plus the power exerted by the stretch of the rope. The speed of the swab at this point far exceeds that of the rope, which again has to coil itself before the slack is taken up by the winding engines ; the swab with its load of oil commences again to descend and the stress put upon the rope when it takes up its load is exceedingly severe ;

naturally, the deeper the well or the larger the quantity of oil to be lifted, the greater the stress to which the rope is subjected.

The writer particularly noticed this in the case of a well which was producing by means of the swab from a depth of 1200 metres 120 tons per 24 hours. On this well the ropes, after being in use on an average about five weeks, had to be discarded owing to their failing at some 200 metres above the swab. It was also noticed that about 6 to 8 seconds after the winding engine had started the upward haul a very perceptible, in fact, a heavy tug or shock was imparted to the derrick. This was undoubtedly caused by the rope taking up its load for the second time, or after the swab had taken its first leap upwards. When the shock was felt in the derrick it was noticed the engines had already wound on to the drum 130 to 160 ft. of rope, and everything points to the fact that between 120 and 140 ft. of rope had been wound on the drum before the swab and its load were set in motion, and therefore represented a stretch of the rope to that extent. The amount of oil lifted in this case was approximately 1/2 ton per trip in casing having an inside diameter of 118 m/m, and ten trips per hour were made.

Of course, this wear and tear could be greatly reduced, if not quite eliminated, by the engines being slowly started up and the speed gradually increased; but with wells where every drop of the production has to be hauled to the surface—and especially where there is a fall off in the production unless the swab is run continuously—it is imperative that the trips be made as quickly as possible, and the usual practice is for the driller, after his engine has made one or two revolutions, to open his throttle valve to the full extent, thus giving the engines the full benefit of the steam in the boilers.

The derrick headwheel over which the swabbing rope passes is one metre or more in diameter, with a "U"-shaped rope groove. It often happens that the drillers, through carelessness, overwind and run up into the crown. If the groove of the wheel is large enough to accommodate the sinker little damage results, as in most cases the sinker just bends itself round the wheel, and unless sparks are caused and the well thereby set on fire, the damage can be adjusted in a very short space of time. It should be mentioned that the greater percentage of oilwell fires are caused in the above manner.

Several instruments have been designed to uncouple, and then to hold suspended in the derrick, the swabbing outfit before it strikes the crown gear. Another appliance is an arrangement by which the blow of the tools is used to actuate cutters and sever the rope, and, as in the previous case, the tools are caught and remain

suspended in the derrick, but owing to the unreliability of these instruments, they are not generally adopted.

The writer wishes to express his sincere thanks to Mr. Arthur W. Eastlake, the Honorary Secretary of the Institution, for the assistance he gave in the revision of this paper.

DISCUSSION.

The President said the members had had a most interesting paper from Mr. Millar. It seemed to him that the engineer could do a great deal from the point of view of fuel economy in the Galician oilfields; but certainly, with the Galician-Canadian system of pole tool drilling, in view of the question of the crystallisation of the metal and other problems the metallurgist should be able to do a good deal of useful work.

The President called upon Mr. Frank Dabell to open the discussion.

Mr. A. Frank Dabell remarked that, accepting the record of the system of drilling in Galicia as a valuable standard for use in countries where the drill could be applied, he would point out that the precedent of the initial failure of the rotary drill to make good was a common one. Almost in every field into which the American rotary driller had gone it had been declared a failure at the start, but eventually it had proved more successful, and it was interesting to note that it was mainly the psychology of the driller which had been responsible for the failure. In that direction one might look forward, after a few years' time, to finding experienced men of less rigid character.

There were two points in the paper which, he thought, were of universal interest. One was the question of water shut-off, and another was that of collapsed casing. Those points were common to all the fields in the world. The system described in the paper of the water shut off in Poland was that of gradually withdrawing the casing some 15 or 20 metres from the bottom of the bore hole, and filling in with clay. The casing was then forced down into the clay until it reached the prepared seat. That meant that an annulus of clay was imprisoned on the outside of the casing between the walls of the bore and the casing itself. The clay in the inside of the tubes was then cleaned out. So far as the use of clay was concerned, he thought it was generally accepted to-day that it was the best medium for closing off the water. He did not think there could be any question about it, and it was very much to be regretted that in many cases people were now attempting to close off water with cement, where clay was equally efficient. Clay was

used in Galicia, but there was one step further which, he thought, should be added to the records before the Institution that evening, and that was that that clay should be forced up at the back of the casing under pressure. It was a comparatively simple operation; after the clay was put in the bore, the bore was filled with water to the top of the casing. A metal cap was put on that casing and the column was then lowered. He thought the members would appreciate that the result was a species of hydraulic ram. The clay was imprisoned in those tubes by the superincumbent water, locked in by the cap on the head of the casing, so that when that casing was lowered, weighing as it might anything from 30 to 70 tons, the weight of it gave a tremendous power for pressing that clay up at the back of the casing, giving practically the same result as that obtained with the rotary system, mudding up the back of the casing. If that pressure be not applied he suggested that, under the system in vogue in Poland to-day, there was a risk of having cartridges of air in the length of that clay, for the reason that when clay was thrown into a well it could not be rammed. People thought they rammed it; they lowered a sinkerbar on a rope to ram the clay at the bottom, but on withdrawing the rammer it was found to be covered with clay. That was defeating the end which was desired to be attained, because the clay was drawn up with the rammer and very often there were spaces left. The hydraulic system was more efficient, for one did not rely only on gravity for obtaining an annulus of clay; it was pressed up from the bottom. He had dealt with the point because he thought that no extra precautions could be afforded to be ignored in the matter of water shut-off.

The next matter to which he desired to refer was that of collapsed casing. The author mentioned in the paper the fact of a number of wells having collapsed for which specific reason could be given, and referred to the question in the following way: "Another very probable cause of collapsed casing is gas shut off behind it after it has been set. It is not the large quantity of gas which is dangerous, as this is noticed by the drillers, and provision can be made to allow for its escape, but rather the small quantities, which come under the heading of gas shows; these are frequently ignored." Personally, however, he was far from convinced that the author had given the right reason as to the cause of collapsed casing. If those shows of gas had sufficient pressure behind them to collapse casing, he thought they would make themselves very pronouncedly evident at the moment of their being opened by the tools. It was known from experience that there were thin strata containing small quantities of gas or oil under great pressure, which, when perforated, gave a violent discharge. Therefore,

if gas did exist in sufficient power to collapse the casing, he suggested it would be evidenced in drilling. There was one point which he would advance as a more probable cause than that given in the paper, namely, the failure efficiently to close off water when commencing the well. As an illustration of that he might mention a well which had been drilled in territory where there was no water. Two years after it had been drilled it collapsed. It had collapsed by water pressure, and yet there was no water in the strata. The cause had been that small leakages, surface leakages, due either to rain, or water being used on the derrick floors had, little by little, run down between the casings and in time had filled the space between the casings and given the requisite collapsing pressure. To remedy that, his suggestion was that the initial shaft casing should be efficiently cemented in order to make certain that surface water could not get in.

With regard to water trapped at the back of the casing, the author, in the case mentioned, showed that when casing was being put into a well all the water must be removed in order that it might not be trapped at the back of the casing and cause collapse. He (the speaker) suggested it was a better system to lower the casing into its place, perforate it, allow the water to drain out, and then cement that perforation.

Mr. Calder said that one of the first drilling systems used to prospect and develop some of the most important oilfields of the world was the Canadian pole tool system, and it was by means of this system of drilling that many of the practical Members had gained their first knowledge of the profession; to-day unfortunately, very little notice was taken of the system or even the necessity of a practical drilling training, young men starting in the oil business did not take any interest in either cable or pole tool drilling, there was nothing but rotary talked about to-day, possibly because it appeared much easier to drill wells with the rotary than with percussive tools.

By means of the pole tool system it was possible, with an experienced overseer, to drill prospecting wells with no other assistance than the natives of the country being prospected; this avoided the bringing in of expensive drillers.

With regard to young men from this country being used as drillers, endeavours had been made to train them in the work, but in most cases without success. This was not surprising, as it was sometimes customary to put learners immediately on a rig and expect them to know all about the work.

Mr. Dabell had referred to the "floating in" of heavy strings of casing, and had suggested that the pipe be perforated after it was landed; in the western oilfields of the U.S.A. floating in of

heavy columns of pipe was of frequent occurrence; there it was the practice to place a thin iron plate at the shoe, the plate being knocked out and chopped up when the complete column of pipe is landed.

Mr. F. Arthur Heaton remarked that he had been in Poland last year, and the first thing that struck him there was that in a big Boryslaw field they were taking from three to four years to drill something like 1,500 metres. No attempt had then been made to try any other system of drilling at all. They were working contentedly along with their Canadian pole system, and everybody was very glad when they got a fishing job. That had got to be altered. He thought Mr. Dabell, if he understood him correctly, had said that the psychology of the driller was at fault. He (the speaker) had always found that there was a striking disinclination on the part of existing operators to try anything new in fields where foreign enterprise had entered. He believed they had now started to try the rotary system there. Everybody would agree with Mr. Calder when he said that he would never prospect with the rotary system; but once a man knew his field, then, so far as the speaker's own experience went, there was nothing to touch it.

Dr. Wm. Hope Henderson thought that added interest would be given to the Paper by information on general costs of operation, labour, material, etc., as such figures are always of importance, and it frequently happens that apparent inefficiency is justified by the economic results due to local conditions, or that certain drilling and production methods remain in use, but would not be employed elsewhere. Therefore, data on costs, etc., might have permitted a wider comparison of the method under consideration.

He also thought it would be of value to know whether the machinery, material, and supplies, were of Continental, British, or American manufacture, and in this respect the terms "standard," "usual" and "common" type of tools, etc., might be more easily appreciated. He believed it would have been an advantage to give both the metric and British weights and measures or either one, throughout the Paper, as the manner in which these figures were given was somewhat confusing to an outsider glancing over the specifications or reducing high figures in m/m to a more tangible size.

With regard to the derrick the author had given the lumber specification in detail, but did not mention the lay-out dimensions, nor the class of general lumber used. Generally one might assume the lumber and timbers to be Oregon Pine and perhaps Redwood sills and so on; but it was rather an interesting point to know what classes of wood were used for different constructions in various countries. As an instance, when operating in Ecuador, South

America, there was an import duty of 50 cents. per kg. on Oregon Pine, and previous advice had indicated there would be no trouble in securing suitable wood for derricks. The country was rich in a great variety of wood, some of which the native authorities considered equal to pine in every way, but none of it was satisfactory except for sills, and Oregon Pine was imported. It may be of interest to mention that one of the derricks was probably a record for a bolted sway-braced wooden derrick, being 116 ft. high, 24 ft. base, for a Rotary, and bolted throughout, giving complete satisfaction, and allowing the lumber to be taken down without loss. He thought one should keep an open mind on the question of steel derricks, and while the author did not appear to favour such construction, he (the speaker) felt that structural steel derricks were of great value, and were more and more coming into prominence owing to the satisfaction which resulted from their use. This was particularly true when cheap lumber and derrick builders were not obtainable.

The author had referred to the handling of strings of casing, often weighing up to 70 tons, and he (the speaker) had thought that the Californian strings were some of the heaviest handled, but even there a 3,000 ft. of 10 in. casing (40 to 54 lbs. per foot) was a very heavy string. He noticed under "Casings" the figures given for 5 in. pipe for up to 1,800 metres were 70–80 metric tons, but at 22.7 kgs. per running metre, he thought this was nearly double what it should be, also the 6 in. seemed too high.

There was a point of interest in the mention of fuel consumption, where 400 cub. metres of gas per minute was shown as used in addition to the oil. Was this correct? This seemed an enormous quantity as it worked out at 20,000,000 cu. ft. per day, which at 35,000 cu. ft. equal to 1 met. ton of oil, would be equivalent as fuel to more than four times the oil consumption shown.

He would like to refer to what had been said about cementing by another speaker, who preferred mud. In his opinion, both mud and cement were advisable, as was common in California, especially with rotary work. In many of those fields where enormous pressures and strains were frequent, and bad water troubles, wells penetrated to great depths through the Tertiaries, passing difficult formations of conglomerates, clays, unconsolidated sands, hard shells, etc., but by use of the proper mud-laden fluid very rapid work was possible, and it was not unusual to set the 2,000 ft. to 3,000 ft. string within thirty days of starting work. The mud backed up the walls, greatly overcoming cavings, gas pressures, and so on; the cement in charges up to 30 tons or more, was pumped in and formed between the pipe and the wall a great reinforcement for the pipe, and thus the combined action minimised the tendency

to collapse which existed when great unequal strains obtained, due to large cavities and other causes.

As to the rotary and the standard methods which had been briefly described in the Paper as being so unsuccessful, he could certainly appreciate why they were unsuccessful. He did not think any rotary man would consider the work as carried out was in any way sound rotary practice. To rig up for standard work as explained in the paper, was not really giving it a fair chance. If a rotary was properly used he did not see why there should be any trouble whatsoever in the territory under discussion. But the real trouble exists in securing the proper men for foreign fields, and few people realise the inducements necessary to entice first-class drillers and production men away from their home country, in addition to which this very important matter is too often left to a Supply Company, instead of the selection being made by a properly qualified person.

The author's comments on the carelessness, lack of system, etc., compared with any other engineering undertaking, applies unfortunately to oil development generally, especially during the initial stages, but these faults are being continually remedied by the employment of more competent men in supervision, so that in certain fields high efficiency obtains. There are many points in the author's Paper which would allow of interesting exchange of views in discussion, as a Paper of this nature is particularly appreciated by those familiar with the exploration and development part of the petroleum industry.

Mr. C. B. McKeever referred to the matter of joints. It was rather curious that in a system which had been used practically in all parts of the world for prospecting purposes for more than thirty years, so little importance should have been attached to perfect joints. That probably was also the reason why no standardisation had, so far, been reached. The perfect joint, which could now be obtained in the United States, was the dry joint, which would shoulder up perfectly without lubricating oil or a washer. The greatest troubles he had ever had to go through had been caused by that inefficient tin or copper washer, which was supposed to make a perfect joint. It was curious that to-day it was not yet recognised in Galicia that a perfect joint was a big factor of safety in drilling, especially in unknown territory.

Mr. Charles Dabell, referring to Mr. Henderson's remarks with reference to the American driller, said that from experience he had found that whenever he had taken a driller from either Canada or the United States to a new country with a new plant it had well repaid him to allow the man to have a word to say in the choice of the material with which he would have to work in the

field to which he was going. One of the most satisfactory methods was to get hold of a man and show him the plant that was being ordered and with which he would have to work.

The author had given various reasons why drilling and under-reaming should not take place together. He (the speaker) should like to add to those reasons one difficulty which he knew from experience was difficult to get over, namely, that when reaming and drilling at the same time the reamer "dogs" would throw the cuttings down on to the shoulder of the bit. The consequence was that the shoulders of the bit got loaded up, and when one came to remove the tools, difficulty was experienced in getting the shoulders of the bit back through the shoe. There was one point which had not been touched upon in connection with Canadian tools. It had been mentioned to him on several occasions that the generation of an electrical current occurred owing to the use of the jockey pulley on the belt, and this had been suggested as the cause of fire in a well which was gassing.

With regard to the question of drilling rods, speaking of the various breakages due to the crystallisation which took place, he had known managers or head drillers on several fields, immediately a well had finished drilling with Canadian tools, making a point of taking the drilling-rods some distance from the well and laying them in a trench, putting in a base of firewood, then the rods and then more wood. The wood was then kindled, and after it had been burned to charcoal, the drilling rods were covered over with earth and left there until perfectly cool, the idea being to anneal them.

The author had touched on the question of the maintenance of plant and tools and had referred to the lack of interest which apparently was taken in the condition of the plant. He thought a good deal of that trouble was due to the fact that some drillers and production men received, as the case might be, "footage" or bonus on production. They reached a point at which it was not to their interest to stop the well for minor repairs. That might account for a large amount of the lack of interest which was apparently shown in the condition of the plant.

Mr. F. M. Penney remarked that it might be of general interest, in reference to what the author had said about the eccentric bit, if he stated that the eccentric bit had also been used on the manilla rope. In the Maikop field in Russia, it was used with considerable success in the soft formations there. He had known as much as 40 ft. per day made in an 8 in. hole, with an eccentric bit on the manilla cable.

Mr. C. B. McKeever, following on what Mr. Penny had said about manilla rope and the eccentric bit, said that in 1909 Mr. Growder in the Sinai Field, and he himself in the Argentine,

had at the same time succeeded in using an eccentric bit with wire cable, and had obtained very satisfactory results. It was a matter of the size of the cable. It could not be done with the ordinary $\frac{7}{8}$ in. or $\frac{3}{4}$ in. cable, but worked well with a $1\frac{1}{4}$ in. cable. The eccentric bits used were of the Galician pattern.

Mr. Millar, in reply, said he quite agreed with Mr. Frank Dabell with regard to the water shut-off. Certainly clay was the very best medium, and the hydraulic ram method was very good. It was far better than putting the clay into the hole and ramming it down because one was always liable to have small gas or air spaces, and therefore a proper setting could not be obtained.

With regard to collapsed casing through gas shows, these gases, when drilled into, were very often under considerable pressure. There was a large initial flow which afterwards settled down, and if it was given time, one or two years to again collect, which it undoubtedly did in very many cases, and the original high pressure was again attained, it was liable to collapse any casing which might be put in. A recent case might be of interest. A fairly strong gas show was struck at about 360 metres. It was left open for a fortnight, while drilling was continued, then it was cased off, and at this period practically no gas was discernible. The casing which shut this gas off, had an 8 mm. wall thickness and the second column with which drilling was being continued at $9\frac{1}{2}$ mm. wall thickness. Six months later the gas brought about collapse of the first casing, and perforated the $9\frac{1}{2}$ mm. casing.

With regard to water, it was also the practice in some cases to perforate the casing and let out the water which had been trapped behind the casing, but in many cases the mining authorities in Galicia would not allow the casing to be perforated, in case it should have to shut-off water which might leak past the water string or where it was not certain as to whether the formation drilled through contained small quantities of water or not. Therefore there was only one thing to do in that case, namely, to bale it out and to free the well of the water before the casing was set; otherwise there was bound to be trouble.

He would very much have liked to have given the costs for drilling and swabbing, but he had had to omit them because the Paper was already too voluminous. For the same reason he had also cut out all British measurements. All the measurements in Galicia were in millimetres, and it would be very difficult to change some of them into inches; in fact it would mean very fine fractions in order to get some of them accurate.

The wooden derricks in Galicia were all built of white pine, and the double derrick which he had shown on the screen would easily carry 250 tons. The gas figures in the Paper had been taken from

Government statistics, and he thought they could be taken as correct—400 cubic metres a minute burned under the boilers.

With regard to the use of the rotary in Galicia, he believed personally that the rotary could be used with success, not on all the fields, but on a great number of them. A great deal depended on the drillers. Most of those people, when they came with a new system, wished to set up records, or to break the records already set up with the Galician Canadian system. That was an impossible thing to do. If one went out with a new system, one had first to study the conditions of the field. It was necessary to go slowly and, if necessary, to change the system to suit the conditions. The American drillers in 1913 tried to break records. For every metre that the Galician Canadian rigs did the American drillers tried to do two. He was quite certain that with care, in certain fields, the rotary could be made a success.

One speaker had alluded to electricity being generated between the belt and the jockey pulley. He had never heard of such an occurrence or of fires being started in this manner, and he was inclined to think that the cause would most likely be found in sparks coming from the break banks. Probably the copper sheathing was out of order. He had known the derrick heads to be highly electrified.

In Galicia a certain class of poles were annealed, but not all of them. Care had to be taken when annealing because, if the poles got too hot, or were kept at a high temperature too long, they would snap when put to work again. Gas ovens and various other methods had been tried for annealing poles, which had been in use, but it was almost impossible to anneal them evenly throughout their total length.

With regard to the maintenance of the plant, he also was of the opinion that a part of the trouble was due to the men receiving either metreage or some kind of bonus on production ; but the chief reason he believed was that the men who were to-day employed on the oil fields had not sufficient mechanical training and therefore did not realise the value of keeping their plant in perfect order.

The President, in proposing a hearty vote of thanks to Mr. Millar for his Paper, said the members all appreciated how valuable it was to have a man actively engaged in drilling in one part of the world, returning to this country for short intervals, and giving the Institution so much valuable information on that particular oil-field. It was to be hoped that when other members of the Institution abroad returned to England they also would bear in mind that papers of the description delivered that evening were most welcome before the Institution.

The vote of thanks was carried and the proceedings terminated.

Mr. Hookham subsequently wrote:—Regarding the remarks concerning the possibilities of fire risk due to the electrification of belts, there is no doubt that the author was correct in emphasising the much more probable causes of ignition of natural gas by friction of brakedrums and in other ways. At the same time it is interesting to note that generation of static electricity on running belts is a danger which is thoroughly well recognised in explosive filling factories, where steps are taken to ensure that the belts used will be treated at intervals of about three months with glycerine and water, also all machines are fully "earthed."

The author pointed out that the method of drilling he was describing depended for its success on there being a considerable slip on the belts, and I would suggest that this is a direct cause of the generation of static electricity rather than the passage of the belt over the jockey pulley.

Mr. Charles Dabell wrote:—I should like to add another objection to those made regarding drilling and reaming at the same time, *viz.*, that the debris cast down by the reamer dogs becoming mixed with the cuttings made by the bit would be most misleading to those concerned with the recording and tabulation of geological data. I take this opportunity of correcting any misunderstanding arising from my remarks on the payment of "footage" and "bonus on production." I am in favour of this course if the bonus is paid to the whole of the Field organisation, without distinction.

Mr. Miller replied to Mr. Nash's letter as follows:—1. The Russian type of bit and underreamer has never been tried on the Galician oilfields in connection with cable drilling with wire ropes. The most probable reason for this was the small diameter of the boreholes, which were generally from 5 in. to 9 in. It was also considered that the weight of the tools would not be sufficient to overcome the resistance offered by the underreamer, which would minimise to a great extent the drilling power of the bit. It would be interesting to know in what diameter holes the combination Russian bit and underreamer were used.

2. With regard to drilling rods, these should be annealed before leaving the rolling mills, after that no further annealing takes place. It would certainly be of advantage if the rods could be periodically annealed before the point of fatigue is reached, but the process of annealing is a slow one, also costly, and would hardly compensate for the cost and trouble involved. The usual practice is, when a string of poles commences to show signs of weakness in a deep well, they are replaced by new ones, and are then used for shallower drilling. Rods, which are no longer of any use for

drilling purposes, are sold to building contractors for ferro-concrete work, and the price realized is up to 40 per cent. of the cost of new rods.

3. In answer to the query as to whether inserted joint casing is satisfactory for shutting off water, I consider it to be quite reliable, provided the joints are properly made and the thickness of the casing wall is sufficient to withstand the pressure of the water to be shut off.

4. When swabbing from an open hole at the bottom, in compact sandstone formations, caving does not result, but where the oil is produced from thin layers of sandstone, interspersed with laminated shales, caving does occur, but not to any appreciable extent. In loose formations, which are prone to cave, it is necessary to case the hole right to the bottom, and to swab through a strainer or through perforated casing. Where the formation permits, however, it is always better to keep an open hole, so that the inflow of the oil is in no way retarded, neither is there the likelihood of the strainer or perforated casing becoming choked by paraffin.

Polish and German Bibliography of the Galician Petroleum Industry, 1875–1922.

A.

ALTH, A.
: Sprawozdanie z podróży w r. 1883 odbytej po wschodniej Galicyi. Sprawozdania Komisji Fizjograficznej Krakow. Volume XVIII. 1884.

ANGERMAN, K.
: Das Gutachten über die Naphta-Terraine Hoszow u. Hoszowczyk bei Ustrzyki in Galizien. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1899. XVII. Nr. 24.

ANGERMAN, K.
: Die Naphtalinie Sokól-Dominikowice-Kobylanka-Kryg-Libusza. Organ des Vereins "Der Bohrtechniker." 1901. Nr. 10, 11.

ANGERMAN, K.
: Kopalnia nafty we Weglówce kolo Krosna. Nafta, Lwów. 1898. VI. Nr. 22.

ANGERMAN, K.
: Das Naphtavorkommen von Boryslaw in seinen Beziehungen zum geologisch tektonische Bau des Gebietes. Tiefbohrwesen, 111. 1905. 174-178, 182-183.

ANGERMAN, K.
: "Nowa linia naftowa w Stróznej." Nafta, Lwów. 1899. VII. Nr. 2.

ANGERMAN, K.
: "Rohölgruben in Weglówka." Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1899. XVII. Nr. 2.

ANGERMAN, K.
: "Tereny naftowe w Lipinkach." Kosmos, Lwów. Volume XVIII. 1893. P. 267.

ANGERMAN, K.
: "Pas naftowy podkarpacki." Nafta, Lwów. 1893. 1. Nr. 35-36, 53-54, 69-70.

ANGERMAN, K.
: "Pas naftowy w Potoku." Kosmos, Lwów. Volume XXIII. 1898. III.

ANGERMAN, K.
: Allgemeine Naphta Geologie. Wien. 1900.

ANGERMAN, K.
: "Dyslokacje w Karpatach." Kosmos, Lwów. Volume XV. 1890. p. 76.

ANGERMAN, K.
"Pas naftowy Bóbrka-Wietrzno-Równe Ze stanowiska geologiczno-technonicznego." Sprawozdania Towarzystwa naftowego w Galicji. 1895. II. Nr. 6, 7, 3.

ANGERMAN, K.
"Pas naftowy Bobrecki." Kosmos, Lwów. Volume XX. 1895. p. 201.

ARADI, V.
"Salz u Erdöllagerstätten der Süd-u.-Ostkarpathen. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. XXVI. 1908.

ARCH, H.
"Das Vorkomen von Erdwache in Galizien. Volkswochenschrift Chemiker und Techniker. 1898. Nr. 1.

Aus dem Ölbergwerk Rogi. Naphta, Lwów. XIV. 1906. str. 106-107.

Aus galizischen Erdölgruben. Drohobycz, Kosmacz, Boryslaw Naphta, Lwów. 1901. IX. Nr. 2, 19.

Aus Galizischen Rohölgruben. Naphta, Lwów. 1900. VIII. Nr. 2, 10.

B.

BAKOWSKI, J.
"Olej skalny stełały." Kosmos, Lwów. Volume VII. 1882. p. 351.

BANDROWSKI, E.
"O istocie i sposobie powstawania nafty." Czasopismo Towarzystwa Technicznego Krakowskiego. 1892. VI. 263-264.

BANDROWSKI, FR.—, SEŃKOWSKI, M.
"O przeróbce mazi ponaftowej na waseline." Kosmos, Lwów. Volume XV. 1890. p. 447.

BARTEL, E.
"Die Erdöl-Bergbau in Pasiéczna." Montan-Zeitung. 1897. 27.

"Bergöl in Galizien." Naphta, Lwów. 1900. VIII. Nr. 14.

Bergwerksproduktion Österreichs im Jahre. 1891, 1892. Statistische Mitteilungen des Ackerbau-Ministeriums, Wien. 1891, 11. Heft. 1. Lief. 1-154. 1892. 1-153.

"Bergwerksbetrieb Osterreichs im Jahre. 1890, 1891. Oesterreichische Zeitschrift für Berg-und Hüttenwesen, Wien. 1891, 39. 1892, 40.

BARTOSZEWICZ, STEFAN.
"Nasza produkcja ropy ijej zuzytkowanie w r 1910, 1911." Nafta, Lwów. XIX. 1911. 59-51. XX. 1912. 51-53.

BARTOSZEWICZ, STEFAN.
"Przemysł naftowy ze stanowiska ekonomiki narodowej." Ropa. V. 1913. Boryslaw. Nr. 9. 189-193.

BARTOSZEWICZ, STEFAN.
"Produkcja ropy w Galicji. w roku 1907 wedle kopalń i miesciecy." Nafta, Lwów. XVI. 1908. 80-82.

BERNHARD, LEOPOLD M.
"Uber die Röhölgruben in Boryslaw." Naphta, Lwów. 1901. Nr. 5, 8.

Betriebs u. Produktionsstatistik des Erdölbergbaues in Boryslaw-Tustanowice nach dem Stande mit End November 1908. Organ des Vereins "Der Bohrtechniker." XVI. 1909.

BIEGAŃSKA, L.
"Nafta i wosk ziemny w Galicji." Ziemia. 1. Warsz. 1910.

BÖHM, M.
"Przyczynki do znajomości galicyj kiej nafty. z. Kosmos, Lwów. Volume XI. 1889.

"Bogactwa naftowe na świecie i ich rozmieszczenie." Nafta, Lwów. XIX. Lwów. 1911.

BRUGGER, FR.
"Entwickelung des galizischen Bohrsystems." Nafta, Lwów. XVI. 1908.

D.

Das neue Rohöl und Erdwachsterrein in Niebylow. Naphta, Lwów. XIV. 1906.

DEUTSCH, S.
: Das vorkommen und die bergmännische Gewinnung des Erdwachses in Boryslaw-Wolanka in Galizien. Oesterreichische Zeitschrift für Berg-und Hüttenwesen, Wien. 1891. XXXIX.

Die Aarischen Petroleumfelder Galiziens. Ungarische Montan Industrie Zeitung, Budapest. Nr. 21. 1913. XIX.

Die Rohölproduktion in Galizien im verflossenen Jahre. Naphta. XIV. 1906.

Die Ein-und-Ausfuhr Statistik Petroleumprodukte in der öster. ung. Mona chie im Jahre 1905. Naphta. XIV. 1906.

Die Erdöl-und-Mineralölprodukte 1910. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1911. XXIX.

Die Abnahme der galizischen Rohölproduktion. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1911. XXIX.

Die Lage der galizischen Naphta-industrie. Naphta. 1901. IX. Nr. 3, 4.

Dobycza czokeryta w Galicji. Kaspij. 1898. Nr. 102, 103.

Dobycza nafty w Galicji. Neftianoje Dielo 1903. Nr. 2.

DUNIKOWSKI, E.
: Die geologische Verhältnisse des Erdölvorkommens in den Staatsdomänen in Galizien. Bohrtechniker. 1898. Nr. 22.

DUNIKOWSKI, E.
: Przyszłość poszukiwan nafty w Galicji. Ropa, Boryslaw. 1911. 1, 11.

DUNIKOWSKI, E.
: Westgalizien En contra Tustanowice. Chemiker und Techniker Zeitung, Wien. XXVII. 1909.

DUNIKOWSKI, E.
: Studja geologiczne w Karpatach. Kosmos, Lwów. Volumes X., XI., XV.

DUNIKOWSKI, E.
: Nowe Odbite źródla nafty. Kosmos, Lwów. Volume XIV. 1889.

DUNISCKI, P.
: Olej skalny i wosk ziemny w Galicji. Kosmos, Lwów. Volume VIII. 1883.

DZIEWOŃSKI, K.
: Sprawozdanie z porównaczego rozbioru kilku rop galicyjskich. Kosmos, Lwów. Volume XXV. 1900.

E.

E. G.
: Petroleumproduktion im Jahre 1908. Chemiker und Techniker Zeitung, Wien. XXVII. 1909.

Eksport produktów naftowych na poszczególne kraje, 1910. Przeglad naftowy, Kraków. 1. 1921. Nr. 7.

Erdölvorkommen in den Staatsdomä nen in Galizien. Zeitschrift für praktische Geologie, Wien. 1899.

Erdwachsgruben in Boryslaw. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1900. XVIII. Nr. 8.

Erdwachsproduktion Galiziens in den Jahren, 1899-1900. Naphta. 1901. IX. Nr. 9.

Erdwachsbau in Galizien und die neuen Bergpolizeivorschriften für denselben. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1900. XVIII.

Ergebnisse der vom k. k. Ackerbau ministerium in Jahre 1902 angesetzten Komission zur Untersuchung der Betriebsverhältnisse des Erdwachs bergbaues in Galizien. Wien. 1900. 1903. 1904.

F.

FABIAŃSKI, J.
: Wiercenie za ropa w komitacie marmaroskim. Nafta, Lwów. 1894. 1.

FAUCK, A.
: Niebezpieczeństwo zawodnie na terenòw przy wierceniu za ropay. Ropa, 1913. V. Boryslaw. Nr. 8.

FAUCK, A.
: Die Fragen der Uhrlagerstä-ten des Erdöles. Organ des Vereins "Der Bohrtechniker," Wien. 1911. XVIII.

FAUCK, A.
: Das Erdöl Galiziens. Stein der Weisen, 1894.

FRIEDBERG, W.
: Wosk ziemny w Galicji. Nafta, Lwów. 1894. 1.

G.

GAWROŃSKI, L.
: Die heutigen Ansichten über die Geologie der Karpathen und über die Naphtalagerstätten. Tiefbohrwesen, Frankfurt am Main. 1907. Nr. V.

GAWROŃSKI, L.
: Dzisiejsze poklady na geologje Karpat i drugorzedne zloza naftowe. Nafta, Lwów. 1907. Lwów. Nr. 15.

Galizische Petroleumindustrie. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. XIV. Nr. 1, 4, 6, 9, 11, 13, 15, 16, 17.

Galizische Petroleum Terraine Brzozów, Kobylanka, Kryg Dominikowice. Chemiker und Techniker Zeitung, Wien. 1897. Nr. 13.

Galicyjski przemysl naftowy we francuskiem oświetleniu. Ropa, Boryslaw. V. 1913. Boryslaw. Nr. 12.

Galizische Petroleum Industrie. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1899. Nr. 8.

Galicyjski przemysl naftowy. Nafta, Lwów. 1897. Nr. 21.

Galizische Erdölindustrie. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1900. XVIII. Nr. 13.

Galizische und rumänische Petroleum. Volkswochenschrift Chemiker und Techniker. 1897. Nr. 12.

Galiziens Rohölbewegung im Jahre 1907. Naphta. XVI. Lwów. 1908.

Galizische Rohöl in der neuen Campagne. Chemiker und Techniker Zeitung, Wien. 1897. Nr. 11.

Galicyjska produkcja naftowa w r, 1912. Ropa, Boryslaw. V. 1913. Boryslaw. Nr. 3.

Gegenwärtiger Zustand der Ölgruben in Schodnica. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1900. XVIII. Nr. 22, 23. Naphta, 1900. VIII. Nr. 20, 21.

Górnictwo i hutnictwo w Galicji. R. Statyst. Galicji-Rutowskiego. 1891. III., 1893. IV.

GRABOWSKI, J.
: Rozbiory ropy surowej. Kosmos, Lwów. Volume 11. 1877.

GRZYBOWSKI, J.
: Foraminiferen der Naphtaführenden Schichten der Umge bung von Krosno. Bulletin de l'Academie des Sciences de Cracovie. 1897.

GRZYBOWSKI, J.
: Geologische Skitze der Umgebung von Schodnica bei Drohobycz in den Ostkarpathen Galiziens. Wien. 1903. Montan Zeitung. 1904. Nr. 11.

GRZYBOWSKI, J.
Kropaczek. : Komunikaty stacji geologicznej w Borysławie, Nowe kopalnie w Schodnicy. Ropa, Borysław. IV. Borysław. 1912.

GRZYBOWSKI, J.
: Die Reserven des Borysławer Ölfeldes. Ropa, Borysław. 1901. 1.

GRZYBOWSKI, J.
: Geologisches Gutacheten über das Naphta Terrain Hoszów Bezirk Ustrzyki dolne. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1900. XVIII. Nr. 16.

GRZYBOWSKI, J.
: Beiträge zur Geologie Borysławs. Naphta 16. Lwów. 1908.

GRZYBOWSKI, J.
: Die wassereinbrüche in Tustanowice. Ropa, Borysław. 1911. 1.

GRZYBOWSKI, J.
: Widoki dalszego rozwoju Borysławia. Ropa IV. Borysław. 1912.

GRZYBOWSKI, J.
: Borysław. Une monographie geologique. Bulletino de l'Academie des Sciences de Cracovie. 1907.

GRZYBOWSKI, J.
Namul wiertniczy. Kosmos, Lwów. Volume XX. 1895.

GRZYBOWSKI, J.
: Mikroskopowe badania namułów wiertniczych z kopalń naftowych. Kosmos, Lwów. Volume XXII. 1897.

GRZYBOWSKI, J.
: Przyczynek do geologji Borysławia. Przeglad techniczny, Nafta, Lwów. 1908.

GULISZAMBAROW, S.
: Ozokerytowy przemysł w Galicji. Kosmos, Lwów. Volume IX. 1884.

H.

HANDEL ROPA.
Ropa. V. Borysław. 1913. 7.

HARAJEWICZ, T.
: O kopalniach. wosku ziemnego, Borysław. Czasopismo Techniczne Lwowskie. 1898. XVI.

HELMHACKER, R.
: Naphta und Ozokerit in Galizien. Berg-und Hüttenwesen Zeitung, Wien. 1897.

HEMPEL, J.
: Z tektoniki Mraźnicy. Ropa. IV. Borysław. 1912.

HILBER.
: Miocen wschodni galicyjski. Kosmos, Lwów. Volume VI. 1881, 1883.

HÖFER, H.
: Zur Geologie des Erdöles. Naphta. 1910. VIII. Nr. 30.

HÖFER, H.
: Zapiski historyczne o nafcie i hipotezach powstania tejze. Nafta, Lwów. 1895. 111.

HOLEBEK, J.
: Der Erdwachsbergbau in Galizien und die neuen Bergpolizei-Vorschriften für denselbem. Montan Industrie Zeitung, Oesterreich-Ungarische, Graz. VII. Nr. 5, 6, 7, 8, 9, 10, 11. 1900.

HOLEBEK, J.
: Betriebs u. Produktions statistik des Erdölbergbaues in Boryslaw-Tustanowice nach dem Stande mit Ende, November, 1908. Oesterreichische Zeitschrift für Berg-und Hüttenwesen, Wien. 57. 1909.

HOLEBEK, J.
: Die geologischen Verhältnisse der Erdwachslagerstätten. Naphta. 1900. VIII. Nr. 8–12.

J.

J. F.
: Kopalnie ropy w Slobodzie rungurskiej. Gazetta naftowa. 1. Lwów. 1912. Nr. 36.

Jahresbericht des galizischen Landes-Petroleum-vereins, 1907. Naphta. 1908. Lwów. XVI.

JEZIORAŃSKI, L.
: Zwierzece pochodzenie ropy naftowej. Przeglad techniczny, Warszawa. 1896. Nr. 9, 10, 11.

K.

KAMINSKI, Z.
: Najwazniejsze urzadzenia w kopalniach galicyjskich w r 1905. Przeglad techniczny 45. Warszawa. 1907.

KAMINSKI, Z.
: Nafta i wosk ziemny w Galicji w r 1905. Przeglad gorniczo-hutniczy, Dabrowa. IV. 1909.

KAMINSKI, Z.
: Tereny naftowe w powiecie Nadwórna. Ropa. IV. Boryslaw. 1912.

KAMIŃSKI, Z.
: Przemysl górniczo hutniczy w Galicji w r., 1904, 1905, 1906. Nafta i wosk ziemny. Przeglad techniczny, Warszawa. 44. 1906. Przeglad gornicno-hutniczy, Dabrowa. 3. 1906. Nr. 10.

Kopalnie ropy. Zagórz-Wielopóle-Tarnawa. Gazeta naftowa. 1 Lwów. w. 1902. Nr. 15, 16.

Kopalnie naftowe w Galicji zachodniej. Nafta, Lwów. 1912. XX.

Kopalnie bitkowskie. Gazeta naftowa. 1. Lwów. 1912. Nr. 223. 1912. Nr. 223.

KLAUDY, J.
: Die oster. Petroleum-industrie. Schmiermaterialen. Chemiker und Techniker Zeitung, Wien. 1897. Nr. 19-22.

Kleczany Oilfelder. Bohrtechniker. 1898. Nr. 3.

KLEIN, R.
: Pierwsza kopalnia oleju skalnego. Bóbrka. Ropa. IV. Borysław. 1912.

Kopalnictwo ropy i wosku ziemnego w Galicji, pod względem, górniczo policyjnym. Sprawozdania Towarzystwa naftowego w Galicji. 1895. 11. Nr. 13-20, 23-24.

KOWALSKI, L.
: O teorji naftowej Dr. J. Nowaka ze stanowiska chemicznego i kapilarno fizycznego. Przeglad, naftowy, Kraków. 1. 1921. Nr. 13, 14.

KREUTZ, F.
: O tworzeniu sie i przeobrażaniu wosku i oleju ziemnego w Galicji. Kosmos, Lwów. Volume IV. r. 1881.

KREUTZ, F.
Przekrójterenu ozokerytu. Kosmos, Lwów. Volume VII. 1882.

KRZYZANOWSKI, K.
: Zestawienie tabelaryczne. Kosmos, Lwów. Volume X. 1885. Volume XI. 1886.

KRZYZANOWSKI, K.
: Oznaczenie wartości nafty zapomoca destylacji. Kosmos, Lwów. Volume XI. 1886.

KRZYZANOWSKI, K.
: Olej skalny w Galicji. Kosmos, Lwów. Volume X. 1885.

L.

LACHOWICZ, BR.
: Weglowodory galicyjskiego oleju skalnego. Kosmos, Lwów. Volume VI. 1881.

LEICHNER, I.
: Erdöl und Erdwachs. Ein Bild galicischer Industrie, Wien. 1898.

LOEWENHERZ, OSKAR.
: Przeglad na sytuacje w przemyśle naftowym. Ropa V. 1913. Borysław. Nr. 17.

LORIÓWNA, Z.
: Analizy kilku rop zachodniej Malopolski. Przeglad naftowy, Kraków. 1. 1921. Nr. 9, 10.

M.

Materjały do historji przemysłu naftowego w Galicji. Nafta, Lwów. 1897. V. Nr. 6, 10, 11, 13, 14.

MENDELEJEW.
Rozkład nafty podczas destylacji. Kosmos, Lwów. Volume IX. 1884. Spr.

MIACZYŃSKI, P.
: Geologische Verhältnisse von Boryslaw-Tustanowice und Umgebung, in Galicien. Ropa, Boryslaw. 1911. 1.

MIACZYŃSKI, M.
: Die geologische Verhältnisse von Boryslaw und Tustanowice. Organ des Vereins "Der Bohrtechniker." IV. 1908. Naphta. XVI. Lwów. 1908.

MIKOLAJCZAK, A.
: Zrodła naftowe w zachodniej Galicji. Kosmos, Lwów. Volume III. r. 1878.

MIKOLAJCZAK, A.
: Produkcja górnicza i hutnicza Galicji w r., 1879. Kosmos, Lwów. Volume V. 1880.

MONTAG, F.
: Kopalnia nafty w Pustym lesie w powiecie gorlickim. Nafta, Lwów. 1894. 11. Nr. 6.

MUCK, J.
: Boryslaw-Wolanka. Naphta. 1900. VIII. Nr. 10.

MUCK, J.
: Uber den Erdwachsbergbau in Boryslaw. Zeitschrift des österreichischen Ingenieur und Architekten Vereins. 1901. 53. Nr. 12.

MUCK, J.
: Rückblick auf die Boryslawer Bergbau Verhältnisse im Jahr, 1899. Naphta. 1900. VIII.

N.

NAWRATIL, A.
: Chemiczno-techniczne rozbiory galicyjskich oleji skalnycha. Kosmos, Lwów. Volume VI. 1882.

Neftjanaja promyszlennost w Galicji. Kasp. 1898. Nr. 63, 64, 67, 69, 71, 72, 75, 76, 77, 81, 82, 92, 195.

Neue Olaufschlüsse in Galizien. Organ des Vereins "Der Bohrtechniker." 1900. XVIII. Nr. 23.

NIEBYLOW.
: Nowy wielki teren naftowy i woskowy we wschodniej Galicji. Lwów. 1905.

NIEDZWIEDŹKI, J.
: Sposób wystepowania nafty w pokładach karpackich. Kosmos, Lwów. Volume V. 1880.

NIEDŹWIEDZKI, J.
: O geologicznych stosunkach przy koleji Stanisławów w-Woronienka w Karpatach wach. galicyjskich. Kosmos, Lwów. Volume T. XXII. 1897.

NOTH, R. J.
: Die petroleumposition Wielopole bei Sanok in Galicjen. Chemiker und Techniker Zeitung. 1897. Nr. 24.

NOTH.
: Uber die Petroleumvorkommen von Komaruk, Mikowa, Luh. Földtani Közlöny. XXXVII. 1907.

NOTH, J.
: Petroleumkoncessionen in dem Gebiete zwieschen Jaslo und Bartfeld mit besonderer Berücksichtigung von Mrukowa-Pielgrzymka bei Zmigrod. Allegemeine österreichische Chemiker und Techniker, Zeitung, Wien. 1899. XVIII. Nr. 1.

NOTH, J.
: Die ärarischen Petroleumfelder Galiziens. Montanist. Rundsch, Wien. 1912. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1912. XXX.

NOTH, R.
: Das Erdölvorkommen in Galizien im Lichte neuen Erfahrungen. Ungarische Montan Industrie Zeitung, Budapest. 1911. XVII. Nr. 4.

NOTH, J.
: Das Erdöl und Erdwachsvorkommen von Boryslaw-Tustanowice in Galizien und die Ursachen der Verwässerung eines Teiles dieser Oelfunderte. Zeitschrift des internat. Vereins Der Bohrtechniker, Wien. 1912. XIX. Mitteilungen des geologischen Gesel., Wien. 1912. V.

NOTH, J.
: Das Petroleumvorkommen in der Umgebung vom Sanok in Galizien. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1908. XXVI.

NOWAK, J.
: Nafta Karpat polskich w świetle geologji regjonalnej. Lwów-Warszawa. 1922.

NOWOSIELSKI, Z.
: O wodzie w Tustanowicach. Nafta. XIX. Lwów. 1911.

O.

Obecne położenie galicyjskiego przemysłu naftowego. Nafta, Lwów. 1898. VI.

Obszary naftowe w Galicji. Nafta, Lwow. 1897. V. Nr. 15.

OEBBECKE.
: Das Vorkommen, die Beschaffenheit und die wirtschaftliche Bedeutung des Erdöles. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1912. XXX.

Olej skalny w Galicji. Gazeta naftowa. 1. Lwów. 1912. Nr. 125, 126, 129, 130, 131, 135, 138.

Olgruben in der Nachbarschaft von Schodnica. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1900. XVIII. Nr. 23.

Olszewski, S.
: Związek zawodnienia szybów w Tustanowicach z tektoniczna budowa Karpat. Ropa. III. 1912. Boryslaw.

Olszewski, S.
: Die Rohöllinie Brzozów-Humniska. Ropa. IV. Boryslaw. 1912.

Olszewski, S.
: Zasoby ropy galicyjskich Karpat. Ropa. IV. Boryslaw. 1912.

Olszewski, S.
: Ropa i gazy jako minerały zastrzeżone. Ropa. V. 1913. Boryslaw. Nr. 8.

Olszewski, S.
: Przyczynek do teorji pochodzenia i wystopowania nafty w Galicji. Kosmos, Lwów. Volume VI. R. 1881.

Olszewski, S.
: Zwalczanie wglebnej wody w Tustanowicach. Ropa IV. Boryslaw. 1912.

Olszewski, S.
: Galicyjski przemysł naftowy i wosku ziemnego na wystawie krajowej we Lwówie. Sprawozdania Towarzystwa naftowego w Galicji. 1894. Nr. 1.

Olszewski, S.
: Akcyjne i udzialowe spólki naftowe w Galicji. Sprawozdania Towarzystwa naftowego w Galicji. 1895. 11. Nr. 10–12.

Olszewski, S.
: Kryzys naftowa w Galicji i zgromadzenie producentów naftowych w Galicji. Sprawozdania Towarzystwa naftowego w Galicji. 1895. 11. Nr. 16, 17.

Olszewski, S.
: Przywóz i wywóz produktów naftowych austro-wegierskig monarchji. Nafta, Lwów. IV. 1896.

Olszewski, S.
: Statystyka kopalń ropy w Galicji. Nafta, Lwów. IV. 1896.

Olszewski, S.
: Ropa galicyjska wobec konsumcji Austro-Wegier i jako produkt wywozowy. Sprawozdania Towarzystwa naftowego w Galicji. 1895. 11.

Olszewski, S.
: Statistik der Rohöl und Erdwachsgruben in Galizien im Jahre 1895. Naphta. 1897. V.

Olszewski, S.
: Przeglad handlowy i statystyczny. Nafta, Lwów. IV. 1896.

Onufrowicz, A.
: Fabrykacja oleji smarowych z nafty. Kosmos, Lwów. Volume IX. 1884.

O spoleczno ekonomicznem znaczeniu galicyjskiego przemysłu naftowego. Nafta, Lwów. IV. 1898.

P.

P.
: Loźiska nafty a ozokeritu w Halići. Vesmir. 34. Praga. 1905.

Pantjuchow.
: Neftjanja promyszlennist Galicii. Zap. Imp. Tech. Obszez. 1898. Nr. 2.

Pawlewski, B.
: O termicznych własnościach galicyjskich produktów naftowych. Kosmos, Lwów. Volume XVIII. 1893.

Pawlewski, B.
: Z przemysłu naftowego produkcja ropy w Galicji a produkcja nafty w Galicji i Austrji. Czasopismo Techniczne Lwowskie. XIV. Nafta IV. 1896.

Pawlewski, B.
: Nafta kleczańska. Kosmos, Lwów. Volume X. 1885.

Pawlewski, B.
: Kilka uwag o nafcie galicyjskiej. Kosmos, Lwów. Volume IX. 1884.

Pawlewski, B.
: Notatka o nafcie galicyjskiej. Kosmos, Lwów. Volume XV. 1890.

Pawlewski, B.
: Uwagi nad handlowemi naftami galicyjskiemi. Kosmos, Lwów. Volume IX. 1884.

Pawlewski, B.
: Ozokeryt z Truskawca. Kosmos, Lwów. Volume XV. 1890.

Pawlewski, B.
: Związek otrzymany przy czyszczeniu nafty wodnikiem sodowym. Kosmos, Lwów. Volume XIV. 1889.

Pawlewski, B.
: Analiza wody towarzyszacej ropie. Kosmos, Lwów. Volume XV. 1890.

Paul-Zuber.
: Geologie der Erdölablagerungen in den galicischen Karpaten. Verhandlungen k.k. geologischer Reichsanstalt, Wien. 1899.

Paul u. Tietze.
: Neue Studien in der Sandsteinzone der Karpathen. Jahrbuch der geologischen Reichsanstalt, Wien. 1879.

PAUL, C. M.
: Sprawozdanie z badáń w Karpatach galicyjskich. Kosmos, Lwów. Volume V. 1880. Volume VI. 1881.

PAUL, C. M.
: Wystepowanie nafty i wosku ziemnego we wschodniej Galicji. Kosmos, Lwów. Volume VI. 1881.

PETIT V.
: Die Feuerbrünste von Boryslaw. Organ des Vereins "Der Bohrtechniker." XVI. 1909.

Petroleum Notizen aus Galizien. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1899. XVII. Nr. 15.

Petroleum in Galizien und Rumänien. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. XXV. 1907.

PIESTRAK, F.
: Plody kopalne w Galicji, olej skalny, wegiel, wosk ziemny. Przeglad górniczo-hutniczy, Dabrowa. 1912. IX.

PIETROWSKI, W.
: Uber die Verarbeitung von Rohölemulsion. Bergbau. und Hütte. 1918. XV.

PIZZALA.
: Production und Ausenhandel in Mineralölen. Chemiker und Techniker Zeitung, Wien. Nr. 17. 1897.

Plody kopalne w Galicji. Gazeta naftowa. 1. Lwów. 1912. Nr. 50.

Produkcja ropy w Galicji w l. polroczu, 1907. Nafta. XV. Lwów. 1908.

Próby wyrobu gasoliny z gazu w Tustanowicach. Ropa. V. 1913. Boryslaw. Nr. 13.

Produkcja szybów Tustanowickich. od r., 1902–1911. Wlacznie. Nafta, XX. Lwów. 1912.

Produkcja ropy w Galicji. Nafta, XV. Lwów. 1907.

Produkcja ropy boryslawsko-Tustanowickiej. Nafta, Lwów. 1913. XXI. Nr. 1, 3, 5, 7, 10, 11, 13, 14, 15, 17, 19, 21, 23.

Produkcja ropy w Galicji i ilość szybów ropnych i wierconych od r. 1912. Nafta, XX. Lwów. 1912.

Produkcja i ekspedycja ropy w Boryslawiu i Tustanowicach w r, 1909 i, 1911. Nafta. XVIII. Lwów. 1909. Nafta. XX. Lwów. 1902. Nafta. XIX. Lwów. 1912.

Produkcja ropy w Malopolsce w r, 1920 na podstawie dat Min. Przem. i Handlu. Przeglad naftowy, Kraków. 1. 1921. Nr. 1.

Produkcja ropy w Boryslawiu i Tustanowicach. Nafta XVI. Lwów. 1908.

Produkcja Górnicza Galicji. Przeglad rolniczy. 11. Nr. 3.

Productionsverhältnisse der galizieschen Petroleum-industrie in den J., 1895–1897. Nafta. 1897. V. Beilage.

Produkcja ropy w Boryslawiu i Tustanowicach. Nafta. XV. Lwów. 1907.

Produkcja kopalń od 1. stycznia do 30, czerwca, 1914. Ropa. VI. Boryslaw. 1914. Nr. 13.

Przemysl i handel naftowy Austro-Wegier w r, 1894. Sprawozdania Towarzystwa naftowego w Galicji. 1895. 11. Nr. 18–20.

PRZETOCKI, W.
: Górnictwo i hutnictwo w Galicji w r, 1891, 1893. Czasopismo Techniczne Lwowskie. 1893. XI. 1895. XIII.

PRZETOCKI, W.
: Górnictwo i hutnictwo w Galicji w r, 1892. Nafta, Lwów. 1894. 11.

PRZETOCKI, W.
: Górnictwo i hutnictwo w Galicji w r, 1894. Czasopismo Techniczne Lwowskie. XIV.

Przemysl naftowy w Boryslawiu i Tustanowicach. Ropa. VI. Boryslaw. 1914. Nr. 1.

Przeglad naftowy za rok, 1913. Ropa. Vi. 1914. Boryslaw. Nr. 3.

P. W.
: Bericht aus dem Centrum der galizieschen Olfelder. Nafta. 1900. VIII. Nr. 19.

R.

RACZKIEWICZ, M.
: Wystepowanie nafty w Galicji. Kosmos, Lwów. Volume IV. 1879.

REDLICH, L.
: Porównanie produktów destylacji ropy naftowej na wolnym ogniu i z parami wodnemi. Kosmos, Lwów. Volume IX. R. 1884.

REHMAN, A.
: Olef skalny i wosk ziemny w Karpatach. Wyj. z. dziela: Karpaty. Nafta, Lwów. IV. 1896.

Rohölproduction in Galizien im J. 1905. Naphta. XIV. 1906.

Rentowność galicyjskich kopalń naftowych. Ropa V. 1913. Boryslaw. Nr. 4.

Rentabilitätsberechnung der galizieschen Rohölgruben. Naphta 1901. IX. Nr. 18.

ROGAWSKI, K.
Wasser in den Tustanowizer Schachten. Ropa. 1911. Boryslaw. 1.

Rohölproduction Galiziens im Jahre. 1907 Nach Gruben und Monaten. Naphta. XVI. Lwów. 1908.

Rohölproduction in Boryslaw-Tustanowice. Nafta XVI. Lwów. 1908.

ROSENBERG, M.
: Górnictwo Galicji jako pole pracy. Ropa. V. 1913. Boryslaw. Nr. 16.

Ruch wiertniczy w. Galicji. Nafta. XV. Lwów. 1907.

Rychlicki, J.
: Przyczynek do geologji pokladów naftonośnych w Groźnym. Kosmos, Lwów. Volume 34. 1909.

S.

Schmiedt.
: Notiz über das geologische Profil durch die Olfelder bei Boryslaw. Verhandlungen der Naturvorschender Gesellschaft, Basel. Band XV. Heft. 3.

Schwarz, P.
: Der galizische Erdölbergbau. Ungarische Montan Industrie Zeitung, Budapest. 1916. XII. 1-10.

Seifert, O.
: Beiträge zur Kenngniss der Ozokeritführenden miocänen Ablagerungen bei Boryslaw am Nordrande der Karpathen. Würzburg. 1902.

Siegfried, E.
: Die Naphtalagerstätten der Umgebung von Solotwina. Petroleum, Berlin, Wien, London, 1912. VII.

Siemiradzki, J.
: Uber ein neues Ozokeritvorkommen in Polanica bei Bolechów in den galizischen Karpathen. Petroleum IX. 1913. Wien. Nr. 5.

Skowroński, J.
: O wystepowaniu weglowodorów naftenowych w galicyskiej ropie naftowej. Metan. Nr. 6-10. 1918. Lwów.

Spis kopalń nafty zestawiony wedlug okregow Górniczych: Jaslo, Drohobycz, Stanislawów. Nafta, Lwów. X. 1902.

Stan kopalń dnia 1. maja, 1913. Ropa V. 1913. Boryslaw. Nr. 4.

Stand der Bohrungen in Boryslaw am 1. Juli, 1909. Organ des Vereins "Der Bohrtechniker." XVI. 1909.

Stan kopalń dnia 15. maja 1913. Ropa. V. 1913. Boryslaw. Nr. 10.

Statystyka. Przeglad naftowy, Kraków. 1. 1921. Nr. 9, 10.

Stystyki. Przeglad naftowy, Kraków. 1. 1921. Nr. 4.

Stan kopalń dnia 15 sierpnia, 1913. r. Ropa V. 1913. Boryslaw. Nr. 17.

Stan kopalń 15. kwietnia 1914 r. Ropa. Vi. 1914. Boryslaw. Nr. 8.

Stan szybów i kopalń w Tustanowicach i Boryslawiu w.r. 1910, 1911. Nafta. XVIII. Lwów. 1910. XIX. Lwów. 1911.

Stanecki, S.
: Wplyw cial promienio-twórczych na twórzenie sie nafty. Lwów. 1921.

Statystyka kopalń ropy i wosku ziemnego w Galicji w.r. 1896. Nafta 1898. VI.

Statystyka górnictwa i przemysłu naftowego w Galicji za rok. 1894. Nafta. Lwów. IV. 1896.

Statystyka kopalń ropy i wosku ziemnego w Galicji w.r. 1893, 1895. Sprawozdania Towarzystwa naftowego w Galicji. 1895. II. Nr. 5. 1895. II. Nr. 21.

Statystyka wosku ziemnego w Galicji w.r. 1897. Nafta. Lwów. 1899. VII. Nr. 9.

Statystyka. Przeglad naftowy, Kraków. 1. 1921. Nr. 13.

Statystyka kopalń naftowych w Tustanowicach za grudzien 1907 i za styczeń. 1908. Nafta. XVI. Lwów. 1908.

Statystyka ruchu kopalnianago i produkcja ropy w Borysławiu i Tustanowicach z końcem listopada 1908 r. Nafta. XVII. Lwów. 1909.

Statystyka. Przeglad naftowy, Kraków. 1. 1921. Nr. 14.

Statistik der Petroleumindustrie in Galizien im Jahre. 1900. Naphta. 1901. IX. Nr. 6, 7.

Statistik des Naphtabetriebes in Galizien. Zeitschrift für Bau. u. Hüttenwesen. 1900. 48. Nr. 51.

Statistik des Naphtabetriebes in Galizien. Statistische Mitteilungen des Ackerbad-Ministeriums, Wien. f.d.J. 1897. Heft. II. Lief. 2.

Statistik des Naphtabetriebes in Galizien für das Jahre. 1899. Naphta. 1901. IX. Nr. 14. Oesterreichische Zeitschrift für Berg-und Hüttenwesen. Wien. 1901. 49. Nr. 28.

Statistik des Naphtabetriebes in Galizien. Statistische Miteeilungen des Ackerbad-Ministeriums. Wien. 1899. Heft. II. Lief. 2. za rok 1900 tamże. 1900. H. II. L. 2.

Statistik des Naphtabetriebes in Galizien im Jahre 1897. Allgemeine österreichische Chemiker und Techniker, Zeitung, Wien. 1899. XVII. Nr. II. 1900. XVIII. Nr. 21.

Statistik des Naphtabetriebes in Galizien im Jahre 1891, 1892. Statistische Mitteilungen des Ackerbad-Ministeriums, Wien. Heft. 2. Lief. 2. 1891, 1892, 1895.

Statystyka kopalń ropy w. Galicji. Nafta, Lwów. 1899. VII. Nr. 2.

Statistik des Naphtabetriebes in Galizien im Jahre 1898. Naphta, 1900. VIII. Chemiker und Techniker Zeitung, Wien. 1898. Nr. 7. Statistische Mitteilungen des Ackerbad-Ministeriums, Wien. 1898. II. Lief. 2.

Statistik des Naphtabetriebes Galiziens im Jahre 1906. Oesterreichische Zeitschrift für Berg-und Hüttenwesen, Wien. 56. 1908. Naphta XVI. Lwów. 1908.

Statistik des Naphtabetriebes in Galizien für das Jahre 1905. Allgemeine osterreichische Chemiker und Techniker Zeitung, Wien. XXV. Wien. 1907. Oesterreichische Zeitschrift für Berg-und Huttenwesen, Wien. 54. 1906.

Statistik des Naphtabetriebes in Galizien im Jahre 1904. Naphta. Lwów. XIV. 1906.

Statistik der Rohölgruben in Tustanowice. Naphta. XVI. Lwów. 1908.

Sulimirski, W.
: O rozwoju kopalnictwa naftowego w Galicji. Ropa V. 1913. Boryslaw. Nr. 22, 23.

SWIETNICKI, W.
: Kilka słów o linji naftowej Brzazów-Humniska. Ropa. IV. Borysław. 1912.

SYNIEWSKI, W.
: Máz jako materjal opalowy. Kosmos, Lwów. Volume XVI. 1891.

SYNIEWSKI, W.
: Ciepło parowania niektórych frakcji ropy z Kleczan. Kosmos, Lwów. Volume XX. 1895.

SYROCZYŃSKI, L.
: Kopalnie oleju skalnego i wosku w Boryslawiu. Kosmos, Lwów. Volume VI. 1881.

SYROCZYŃSKI, L.
: Korzysci badań naukowych ola nafty w Galicji. Kosmos, Lwów. Volume IX. 1884.

SZAJNOCHA, W.
: Wosk ziemny w Galicji. Przewodnik naukowy i literacki. 1894.

SZAJNOCHA, W.
: Das Erdölvorkommen in Galizien im Lichte neuer Erfahrungen. Mitteilungen des geol. Ges. Wien. 1911. IV. Organ des Vereins "Der Bohrtechniker," Wien. 1911. XVIII.

SZAJNOCHA, W.
: O przemyśle naftowym i wosku ziemnym w Galicji. Sprawozdania Towarzystwa naftowego w Galicji. 1895. II. Nr. 2.

SZAJNOCHA, W.
: O przemyle górniczym w Galicji. Nafta, Lwów. 1894.

SZAJNOCHA, W.
: Pochodzenie Karpackiego oleju skalnego. Nafta, Lwów. 1899. VII. Nr. 1-3.

SZAJNOCHA, W.
: Die Petroleumindustrie Galiziens. Oesterreich-Ungarisches Revue. 1899. XXV. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1900. XVIII. Nr. 6, 7.

SZAJNOCHA, W.
: Górnictwo, hutnictwo przemysł naftowy i materjały budowlane na wystawie krajowej. Przeglad Polski. 1894. 113.

SZAJNOCHA, W.
: Plody kopalne Galicji. Kosmos, Lwów. Volume XVIII. 1893. XIX. 1894.

SZAJNOCHA, W.
: Stosunki geologiczne kopalni oleju skalnego w Slobodzie rungurskiej. Kosmos, Lwów. Volume VI. 1881.

SZAJNOCHA, W.
: Studja geologiczne w Karpatach Galicji zachodniej. Kosmos, Lwów. Volume IX. 1884. XI. 1886.

ŁUNOCHA, W.
: Przekrój warstw podkarpackich miedzy Truskawcem a Drohobyczem. Kosmos, Lwów. Volume 34. 1909.

CZEPANOWSKI, S.
: Übersicht der Naphtaindustrie für das Jahre 1896. Chemiker und Techniker Zeitung, Wien. 1897. Nr. 5, 9.

CZEPANOWSKI, S.
: Przeglad przemysłu naftowego za rok, 1896. Nafta, Lwów, 1897. V. Nr. 1.

RUJSKI, W.
: Stosunki przemysłu naftowego w dobie obecnej. Lwów. 1910.

SZYMBARK.
: Petroleumwerk bei Gorlice. Chemiker und Techniker Zeitung, Wien. 1898. Nr. VI.

T.

THOMKE U. WALTER.
: Über die Situation der Petroleumposition um Ustrzyki dolne. Bohrtechniker. III. Nr. 8, 9, 13.

TIETZE, E.
: Beiträge zur Geologie von Galizien. Jahrbuch der geologischen Reichsanstalt, Wien. 1889. Band I. Heft 2.

TOLLOCZKO, S.
: Kilka unaliz gazu ziemnego z szybu wiertniczego Towarzystwa naftowego: Kalusz. Kosmos, Lwów. Volume 38. 1913.

TOLWIŃSKI, K.
: Studjum o złożach ropnych i Wodach podziemnych Boryslawia na tle budowy geologicznej. Przeglad naftowy, Krakow. I. 1921. Nr. 6, 7, 8, 9–10.

Tloczenie za listopad, grudzien, 1913. Ropa V. 1913. Boryslaw. Nr. 23. Ropa VI. 1914. Boryslaw. Nr. 1.

Tloczenie za styczén, luty, marzec kwiecień, maj, czerwiec, lipiec, 1914. Ropa VI. 1914. Boryslaw. Nr. 2, 4, 7, 9, 11, 13, 15.

Tustanowice—Boryslaw. Wykaz produkcji ropy poszczególnych szybów od poczatku istnienia. Gazeta naftowa. I. Lwów. 1912. Nr. 9–13.

U.

Über die galizischen Ölterrains. Chemiker und Techniker Zeitung, Wien. 1898.

URBAN, H.
: Galizische Oelfelder Potok bei Krosno, Krościenko bei Krosno, Gorlicer Kreis, Szymbark, Pasieczna, Kleczany, Ustrzyki dolne. Volkswochenschrift Chemiker und Techniker Zeitung. 1897. Nr. 1, 2, 3, 5, 6.

W.

WALTER, H.
: Nummulity w szybie kopalnym miedzy Tustanowicami a Boryslaw. wiem. Kosmos, Lwów. Volume IX. 1884.

WALTER, H.
: Nowy teren naftowy. Kosmos, Lwów. Volume XIX. 1894.

WALTER, H.
: Der Schacht Nr. 62, in Potok. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1900. XVIII.

WALTER, H.
: Ein neues Naphtaterrain. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1894. Nr. 2.

WALTER, H.
Przyczynek do geologji Karpat. Kosmos, Lwów. Volume VIII. 1883.

WALTER, H.
: Przekrój w środkowych Karpatach z Chyrowa do Sturzycy. Kosmos, Lwów. Volume V. 1880.

WALTER, H.
: Boryslaw. Chemiker und Techniker Zeitung, Wien. 1897. Nr. 4.

WALTER, H.
: Geologiczne studja okplicy Brzostka, Strzyżowa, Ropczyc i Debicy. Lwów. 1895. po niem. Eohrtechn. III. Nr. 1–5.

Wielezyński i Gruszkiewicz: Nowy horyzont ropyy w Boryslawiu. Przeglad techniczny naftowa. I. Lwów. 1907.

WALTER—DUNLKOWSKI.
Geologiczne stosunki naftonośnego obszaru zachodnio-galicyjskidh Karpat. Kosmos, Lwów. VII. 1882. VIII. 1883.

WISCHIN, R.
: Rzut oka na przemysl naftowy. Nafta. 1896. IV.

WISCHIN, R.
: Umschau in der heimischen Mineralöl Industrie, Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. XIV. Nr. 5.

WISPEK, P.
: O technicznem zastosowaniu odpadków naftowych. Kosmos, Lwów. XI. 1886.

WITTIG, R.
: Das Petrol-Bergwerg Harklowa, West-Galizien. Chemiker und Techniker Zeitung, Wien. 1901. XIX. Nr. 23.

WOLSKI, W.
: Kopalnie nafty w Schodnicy. Nafta, Lwów. 1893. I.
Wykaz wywieziony ropy galicyskiej w r, 1901. Nafta, Lwów. 1902. X.

Wykazy produkcji ropy Boryslawia i Tustanowic. Ropa. III. Boryslaw. 1912.

Wykaz produkcji ropy kopalń oleju skalnego stanislawowskiego okregu górniczego za maj, 1921. XXX. Czerwiec. 1921. Przeglad naftowy, Kraków. I. 1921. Nr. 11, 12.

Wykaz galicyjskich producentów ropy we wrześniu 1894 r. Sprawozdania Towarzystwa naftowego w Galicji. 1894. Nr. 5.

Wykaz przetloczonej ropy w r 1912. Zestawiony według kopalń i miesiecy przez biuro statystyczne czasopisma: ROPA. Ropa V. 1913. Boryslaw. Nr. 2.

Wykaz ropy przetloczonej w miesiacach 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. Ropa V. 1913. Boryslaw. Nr. 3, 5, 7, 9, 11, 14, 15, 18, 20, 21.

Wykaz produkcji ropy kopalń oleju skalnego stanislawowskiego okregu górniczego za luty, marzec, maj, kwiecien 1921 r. Przeglad naftowy, Kraków. I. 1921. Nr. 2, 5, 8, 11, 12.

X.

Xenos.
: O terenie naftowym: Kleczany położonym w zachodniej Galicji. Nafta 1898. VI. Nr. 10, 17, 4.

Z.

Zaloziecki, R.
: Übersicht über die galizische Petroleumindustrie im Jahre., 1898. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1899. XVIII.

Zaloziecki, R.
Odbarwianie wosku ziemnego. Kosmos, Lwów. Volume XII. 1887.

Zaloziecki, R.
: Badania nad skladem chemicznem rop galicyjskich. Chemiker polski. VII. Warszawa. 1907.

Zaloziecki, R.
: Wobronie galicyjski produkcji naftowej. Nafta. 1902. X.

Zaloziecki, R.
: Rózbiór gazów z szybu kopalni ropy S. Stawiarskiego i sp. w Wójtowy kolo Gorlic. Sprawozdania Towarzystwa naftowego w Galicji. 1895. II. Nr. 5.

Zaloziecki, R.
: Badania atmosfery gazowej kopalń wosku ziemnego. Kosmos, Lwów. Volume XVIII. 1893.

Zaloziecki, R.
: Kwestja olefinów w nafcie galicyjskiej. Kosmos, Lwów. Volume XI. 1886.

Zaloziecki, R.
: Galicyjska nafta eksportowa. Nafta, Lwów. 1898. VI. Nr. 15.

ZALOZIECKI, R.
: Der Erdwachsbergbau in Galizien und die neuen Bergpolizeivorschriften für denselben. Naphta, 1900. VIII. Nr. 5, 6.

ZALOZIECKI, R.
: Przemysł naftowy na wystawie krajowej we Lwowie w r., 1894. Przegląd Techniczny, Warszawa. 1895. XXXII.

ZALOZIECKI, R.
: Otrzymywanie cerezyny z ozokerytu. Kosmos, Lwów. Volume XII. 1887.

Z Borysławia i Tustanowic. Nafta, Lwów. XVI. 1908.

Z kopalń zachodnio galicyjska. Nafta, Lwów. XVIII. 1910.

Ze statystyki naszego przemysłu w r., 1911. Nafta, Lwów. 1913. XXI. Nr. 9.

Zestawienie produkcji Borysławia za r., 1913. Ropa. VI. 1914. Borysław. Nr. 3.

Ze statystyki naszego przemysłu w r., 1912. Nafta, Lwów. 1913. XXI. Nr. 3.

Ze statystyki przemysłu naftowego. Ekon. Pola. 1894. XVII.

ZUBER, R.
: Orzeczenie geologiczne o występowaniu nafty w okolicy Brzostka. Nafta. 1894. II.

ZUBER, R.
: Dział naftowy na wystawie krajowej. Nafta, Lwów. 1894. II.

ZUBER, R.
: Rozmieszczenie obszarów naftowych w Karpatach. Nafta, Lwów. 1895. III.

ZUBER, R.
: Kilka uwag o terjach powstawania nafty. Nafta, Lwów. IV. 1896.

ZUBER, R.
: Die Karte der Petroleúm Gebiete in Galizien. Bohrtechniker. 1897. Nr. 18, 19.

ZUBER, R.
: Geologja pokładów naftowych w Karpatach galicyjskich. Lwów. 1899.

ZUBER, R.
: Obszary naftowe w Galicji. Nafta, Lwów. 1897. V. Nr. 15.

ZUBER, R.
Borysław i jego przyszłość. Nafta, Lwów. 1894. II.

ZUBER, R.
: Atlas geologiczny Galicji. Tekst do zeszytu II. Kraków. 1888.

ZUBER, R.—, KREUTZ.
: Stosunki geologiczne okolic Mraźnicy i Schodnicy. Kosmos, Lwów. Volume VI. 1881.

ZUBER, R.
: Studja geologiczne we wschodnich Karpatach. Kosmos, Lwów. Volumes VII., VIII., IX., X., XII.

ZUBER, R.
: Budowa geologiczna Karpat we wschodniej Galicji. Kosmos, Lwów. Volume VIII. 1883.

ZUBER, R.
: Uwagi nad Olszewskiego teorja pochodzenia nafty w Galicji. Kosmos, Lwów. Volume VI. 1881.

ZUBER, R.
: Die Öl und Wasserhorizonte von Boryslaw-Tustanowice. Petroleum, Berlin, Wien, London. 1912. VII.

ZUBER, R.
: Sprawa pojawienia sie wody w kopalniach w Tustanowicach. Nafta. XIV. Lwów. 1911.

ZUBER, R.
: Kopalnie nafty w Ropie i Siarach. Kosmos, Lwów. Volume XIX. 1894.

ZUBER, R.
Geologiczne warunki wystepowania nafty w Galicji. Czasopismo Towarzystwa Technicznego Krakowskiego. 1885. Nr. 10, 11. Lwów.

ZUBER, R.
: Flisz i nafta. Lwów. 1918.

ZUBER, R.
: Mapa obszarów naftowych w Galicji. Lwów. 1897. 1 : 75,000.

ZUBER, R.
: Atlas geologiczny Galicji. Tekst do zeszytu XVII. Arkusz Skole. Krakow. 1905.

ZUBER, R.
: Geologie der Erdölablagerungen in den galizischen Karpathen. Lemberg. 1899.

ZUBER, R.
: Zarys budowy Polnocno-wschodnich Karpat fliszowych. Lwów. 1915.

ZUBER, R.
: Nowe zródlo oleju skalnego w Karpatach. Kosmos, Lwów. Volume V. 1880.

ZUBER, R.
: Spostrzeżenia geologiczne poczynione w Karpatach wschodnich. Kosmos, Lwów. Volume XVIII. 1883. Volume IX. 1884.

Zur Lage von Boryslaw. Naphta, Lwów. 1896. XIV.

Zur galizischen Petroleum krise. Allgemeine österreichische Chemiker und Techniker Zeitung, Wien. 1907. XXV.

REVIEW.

Review of "Geology of the Tertiary and Quaternary Periods in the North-West Part of Peru," by T. O. Bosworth, D.Sc., M.A., F.G.S., F.R.G.S., M.Inst.P.T.

Dr. Bosworth's book is one of a type of which we would gladly see more. The author was fortunate in having the opportunity of undertaking an exhaustive geological examination of the Tumbes desert region, which lies in the extreme north-west corner of Peru just south of the Ecuador frontier and comprises the productive oilfields of Zorritos, Lobitos and Negritos.

The origin of the book made it, perhaps, inevitable that a certain amount of repetition would occur, but it is a pity that such minor defects as, for example, the almost word-for-word reappearance of part of pages 250-2 on pages 284-6 were not avoided.

Parts I and II deal respectively with the Tertiary Geology and Palæontology, the latter being jointly handled by Messrs. Henry Woods, T. Wayland Vaughan, J. A. Cushman and H. L. Hawkins, who deal in turn with the Mollusca and Crustacea, the Corals, the Foraminifera and an Echinoid, collected by Dr. Bosworth. The series of twenty-four beautiful plates which accompany this section should prove invaluable to any future workers in this or the adjoining regions.

The Tertiary deposits are divided into three formations, the Negritos, Lobitos and Zorritos, of which the first two are ascribed to the Eocene and the last to the Miocene. They are throughout of shallow water origin and have a total thickness of some 20,000 feet. As, however, their base is nowhere visible, this may be exceeded. The most remarkable feature is the absence of any evidence of folding and the block-faulting which is so intense that the whole formation is described by the author as a "giant crush breccia" in the zone of the Pacific geo-fault. The faulting extends into the older, underlying rocks to the proximity of the resistant mass, of which it is probably due that the outcome of the crustal movements was faulting rather than folding. It is to be remarked that further to the north, outside of the area dealt with, folding as well as faulting occurs in the Tertiaries.

In the third section an exemplary clear account is given of the processes by which the series of "tablazos" or plateaus and the great breccia fans which constitute the Quaternary deposits were formed. A succession of oscillations took place the resultant of which was the emergence of part of the continental shelf and the retreat of the coast westwards. The effects of four episodes of uplift and submergence are traced, and it is pointed out that the last of these, the "Salina episode," is still in progress and has given rise to the salt-saturated, low-lying "Salina" plains which fringe the coast; it is strictly similar to the previous ones, the oldest of which built up a "tablazo," parts of which now lie 1,100 feet above sea-level.

The fourth section deals with the desert conditions and processes. The climate in this area is characterised by complete aridity except at intervals of 30 or 40 years, when torrential rains and floods occur. Perhaps the most valuable contribution made by Dr. Bosworth to our knowledge of desert phenomena is his description of the very great part played by the sun's heat alone in comminuting the talus brought down during the periodical deluges. The vexed question of dune formation receives attention, and issue is definitely joined with Mr. R. D. Oldham on this point. It is suggested that crescentic dunes can only arise in "dead air" areas, which

is not in accord with the views of other authorities, by whom this form is regarded as typical of open desert. Dr. Bosworth's presumption that sulphur can be liberated from sulphates by the reducing action of petroleum would appear to require considerably more support.

The fifth and last section of the book is marred by the refusal of one of the Oil Companies to allow the author to make full use of his material. It is very doubtful whether, in the long run, narrow restrictions of this kind can be justified from any aspect. Dr. Bosworth is to be congratulated on having been able, with this handicap, to present so lucid an exposition of his subject. The oil occurs at various horizons throughout the whole of the Tertiary down to 1,500 feet above the lowest known beds, but it is probable that many of the sands have received their enrichment from other beds with which they have been brought into contact by the excessive faulting.

Dr. Bosworth's conclusion that "the geological study of these oilfields has failed to establish any definite principle governing the distribution of oil in the fault blocks" emphasises the need of taking a wide view of geological problems. If it were possible to correlate the formations of this area with those of adjacent ones where folding rather than faulting has been the rule, not only might information of the greatest value in elucidating the very difficult questions with which the author was confronted be acquired, but the enquiry might lead to the discovery of further oil-bearing areas.

It is hardly necessary to say that all future work in this and the adjoining districts must be based upon Dr. Bosworth's valuable researches. His book has, of course, only a limited appeal although there is much in it, particularly in Section IV, of general interest to geologists. It is to be hoped that his example will be followed by workers in other parts of the world as regards both the publication of the results of their investigations and the clarity and method with which the matter is set forth.

E. H. C. C.

December 1st, 1922.

CURRENT BIBLIOGRAPHY.

Compiled by W. J. Wilson, A.C.G.I., A.I.C.

1. Geological.

Geology of the Tertiary and Quaternary Periods in the North-West Part of Peru.—T. O. Bosworth. Macmillan.

Geology of the Cement Oil Field.—F. G. Clapp. *Trans. Am. Inst. Mining Met. Eng.* **65**, 156. *Chem. Abstr.* **16**, 2829.

"Die Erdöllagerstätten; Grundlagen der Petroleumgeologie." E. Blümer. F. Enke, Stuttgart.

The Geology of the Wiles Area.—Ranger District, Texas. C. E. Dobbin. *U.S. Geol. Surv. Bull.* 736 c.

Lateral Migration of Oil up Low Angle Dips.—*Petr. Times* **8**, 159. *Chem. Abstr.* **16**, 3387.

Report on Structural Materials along the St. Lawrence River, between Prescott, Ontario and Lachine, Quebec.—J. Keele and L. H. Cole. *Canad. Dept. of Mines Rept. Petr. World* **19**, 468.

An Introduction to Sedimentary Petrography.—H. B. Milner. T. Murby and Co., London.

Oilfields that "Came Back."—*Oil Engineering and Finance* **2**, 600.

2. Geographical.

The Oilfields of Mexico.—Pan-American. *Petr. Times* **8**, 393, 429, 691.

Production, Marine Transportation and Taxation of Mexican Petroleums.—V. R. Garfias. *Trans. Am. Inst. Mining Met. Eng.* **65**, 523. *Chem. Abstr.* **16**, 2775.

Petroleum Industry of Trinidad.—G. A. Macready. *Trans. Am. Inst. Mining Met. Eng.* **65**, 58. *Chem. Abstr.* **16**, 2775.

The El Dorado Field, Arkansas.—*Oil Engineering and Finance* **2**, 277, 306.

The Search for Oil in Australia.—*Petr. Times* **8**, 427.

Petroleum in Zambesia.—*Petr. Times* **8**, 428.

Burkburnett Oilfield, Wichita Co., Texas.—H. W. Bell and J. B. Kerr. *Oil Engineering and Finance* **1**, 805; **2**, 59, 197, 325.

Analyses of Oils from Kevin-Sunburst Field in Montana.—U.S. Bur. Mines. *Oil Engineering and Finance* **2**, 332.

The Petroleum Industry of Japan.—J. Kirwan. *Oil and Gas J. Petr. Times* **8**, 450.

THE GROZNY OIL INDUSTRY; ITS PRESENT POSITION.—*Ekonomitcheskaya Jizn. Petr. Times* **8**, 463.

THE MEXICAN OILFIELDS. *The Lamp. Petr. Times* **8**, 477, 519, 573, 621. *Oil News* **12**, 1070.

THE PETROLEUM POSITION IN BOLIVIA.—*Petr. Times* **8**, 488.

THE DISCOVERY OF OIL IN ESTHONIA.—*Petr. Times* **8**, 501.

OFFICIAL TRINIDAD OIL REPORT FOR 1921.—R. R. Thompson and A. P. Catherall. *Petr. World* **19**, 409. *Oil News* **12**, 986.

NETHERLANDS EAST INDIES OIL INDUSTRY.—H. A. N. Bluett. *Petr. World* **19**, 413.

ANALYSIS OF MONTANA OIL.—U.S. Bur. Mines. *Petr. World* **19**, 434.

RESUMÉ OF PENNSYLVANIA–NEW YORK OIL FIELD.—R. H. Johnson and S. Huntley. *Trans. Am. Inst. Mining Met. Eng.* **65**, 151. *Chem. Abstr.* **16**, 2828.

RISE AND DECLINE IN PRODUCTION OF PETROLEUM IN OHIO AND INDIANA.—J. A. Bownocker. *Trans. Am. Inst. Mining Met. Eng.* **65**, 108. *Chem. Abstr.* **16**, 2828.

IRVINE OIL DISTRICTS, KENTUCKY.—S. St. Clair. *Trans. Am. Inst. Mining Met. Eng.* **65**, 165. *Chem. Abstr.* **16**, 2828.

OIL FIELDS OF KENTUCKY AND TENNESSEE.—L. C. Glenn. *Trans. Am. Inst. Mining Met. Eng.* **65**, 122. *Chem. Abstr.* **16**, 2828.

OIL POSSIBILITIES IN NORTHERN ALABAMA.—D. R. Semmes. *Trans. Am. Inst. Mining Met. Eng.* **65**, 140. *Chem. Abstr.* **16**, 2829.

PETROLEUM RESOURCES OF KANSAS.—R. C. Moore. *Trans Am Inst. Mining Met. Eng.* **65**, 97. *Chem. Abstr.* **15**, 2829.

PETROLIFEROUS ROCKS IN SERRA DA BALIZA.—E. P. de Olivera. *Trans. Am. Inst. Mining Met. Eng.* **65**, 241. *Chem. Abstr.* **16**, 2829.

OIL FIELDS OF RUSSIA.—A. B. Thompson and T. G. Madgwick. *Trans. Am. Inst. Mining Met. Eng.* **65**, 17. *Chem. Abstr.* **16**, 2829.

OIL FIELDS OF PERSIA.—C. M. Hunter. *Trans. Am. Inst. Mining Met. Eng.* **65**, 8. *Chem. Abstr.* **16**, 2829.

THE FUTURE OF THE GALICIAN PETROLEUM INDUSTRY.—K. Friedl. *Oil Engineering and Finance* **2**, 353.

THE OIL REGION OF META, COLOMBIA.—H. C. Willcox. *Oil Engineering and Finance* **2**, 359.

COLOMBIAN OILFIELDS.—L. G. Huntley and S. Mason. *Mining and Metallurgy (Sept.). Oil Engineering and Finance* **2**, 362. *Petr. World* **19**, 401.

WHAT IS THE MATTER WITH TRINIDAD?—E. H. Cunningham-Craig. *Oil Engineering and Finance* **2**, 364.

TOPOGRAPHY AND GEOLOGY OF NORTHERN SINAI.—*Petroleum Research Bull.* 10. Government Publications Office, Ministry of Finance, Cairo. *Oil Engineering and Finance* **2**, 413.

THE KEVIN-SUNBURST OIL FIELD, MONTANA.—A. J. Collier and W. W. Bayer. *U.S. Geol. Surv. Rept.*

STRUCTURE AND OIL AND GAS RESOURCES OF THE OSAGE RESERVATION, OKLAHOMA.—P. V. Roundy, K. C. Heald and G. B. Richardson. *U.S. Geol. Surv. Bull.* 686 E.

SOUTH AMERICA LOOMING AS AN OIL PRODUCER.—W. O. Fanning. *Oil and Gas J.* **21**, (9), 11, 82. *Chem. Abstr.* **16**, 3197.

ANALYSIS OF CZECHOSLOVAKIAN PETROLEUM.—F. Schulz. *Petroleum* **18**, 331. *Chem. Abstr.* **16**, 3199.

THE NAPHTHA-BEARING TERRAINS OF TURKZOVKAM, IN THE WHITE CARPATHIANS.—J. J. Jahn and E. Schnabel. *Petroleum* **18**, 441. *Chem. Abstr.* **16**, 3199.

THE OILFIELDS OF MESOPOTAMIA.—*The Oil Weekly. Oil News* **12**, 1135.

THE OILFIELDS OF MEXICO TO-DAY.—*Oil News* **12**, 1070, 1147.

CONSUMPTION OF GASOLINE IN LATIN AMERICAN COUNTRIES.—*U.S. Com. Repts., August, p.* 381.

NEW PERUVIAN REGULATIONS GOVERNING PETROLEUM CONCESSIONS.—*U.S. Com. Repts., August, p.* 384.

FRENCH IMPORT DUTIES.—*U.S. Com. Repts., August, p.* 408.

GASOLINE TRADE OF THE FAR EAST.—*U.S. Com. Repts., August, p.* 528.

PRODUCTION OF MINERAL OIL IN FRANCE.—*U.S. Com. Repts., August, p.* 606.

GEOLOGICAL CHARACTERISTICS AND DEVELOPMENT OF THE EL DORADO FIELD.—*Oil Engineering and Finance* **2**, 467.

PETROLEUM IN MADAGASCAR.—H. Gault and A. Merle. International Oil Congress, Paris. *Oil Engineering and Finance* **2**, 476.

THE BITUMINOUS LIMESTONES OF SYRIA.—I. Veyrier. International Oil Congress, Paris. *Oil Engineering and Finance* **2**, 478.

PETROLEUM ENGINEERING IN THE SLICK OILFIELD, CREEK COUNTY, OKLAHOMA.—F. X. Schwarzenbek and J. S. Ross. U.S. Bur. Mines. *Oil Engineering and Finance* **2**, 509.

AN UNUSUAL PETROLEUM OCCURRENCE.—*Petr. Times* **8**, 604.

THE OIL MINES AT PECHELBRONN.—*Petr. Times* **8**, 613.

REPORT ON THE MINERAL INDUSTRY OF EGYPT.—Government Publications Office, Ministry of Finance, Cairo. *Petr. Times* **8**, 619.

NATRONA COUNTY STRUCTURES AFFORD GOOD HEAVY OIL POSSIBILITIES.—L. P. Smith. *Nat. Petr. News* **14**, (32), 45. *Chem. Abstr.* **16**, 3387.

LA POLITICA DEL PETROLEO.—M. J. Lagos. Instituto Popular de Conferencias, Buenos Ayres.

THE OIL INDUSTRY IN POLAND.—S. Bartoszewicz. *Petr. Times* **8**, 633.

THE TOTAL PRODUCTION OF THE BAKU, GROSNY AND URAL-EMBA OILFIELDS FOR THE FIRST HALF OF 1922.—*U.S. Commerce Repts., Sept., p.* 730.

PETROLEUM FIELDS IN SAKHALIN.—*U.S. Commerce Repts., Sept., p.* 730.

METHANE GAS NEAR VAUX-EN-BUGEY (AIN).—*U.S. Commerce Repts., Sept., p.* 787

MESOPOTAMIAN OIL RESERVES.—E. H. Pascoe. *Oil Engineering and Finance* **2**, 573.

REGULATIONS FOR EXPLOITING ALASKA.—*Oil Engineering and Finance* **2**, 574.

VENEZUELA'S PETROLEUM RESOURCES.—*Petr. Times* **8**, 708.

JAPAN'S TRADE DURING 1921.—British Embassy at Tokio. *Petr. Times* **8**, 708.

AMERICA'S PETROLEUM RESOURCES.—F. M. van Tuyl. *Petr. Times* **8**, 743.

PETROLEUM IN BRITISH BORNEO.—*Petr. Times* **8**, 765.

COMMERCIAL DEVELOPMENT OF THE ALBERTA BITUMINOUS SANDS.—*Petr. Times* **8**, 767.

3. DRILLING AND FIELD OPERATIONS.

MATHEMATICS IN FIELD WORK.—J. T. Norman. *Petr. Times* **8**, 407.

CORE DRILLING IN OILFIELDS.—*Petr. Times* **8**, 538.

A METHOD OF DISTINGUISHING FUSED CORES.—*Oil Engineering and Finance* **2**, 438.

THE USE OF CEMENT AND CONCRETE IN THE OIL INDUSTRY.—G. Howell. *Oil Engineering and Finance* **2**, 465.

TAKING CORES IN ROTARY DRILLING OPERATIONS.—J. R. Suman. *Mining and Metallurgy. Oil Engineering and Finance* **2**, 527. *Petr. Times* **8**, 669.

IMPROVED COUPLING FOR ROTARY DRILL PIPES, ETC.—*Petr. Times* **8**, 644.

NOTES ON THE CONTROL OF OILWELLS AND THE USE OF SCREEN ON THE APEX (TRINIDAD) OILFIELD.—H. C. B. Hicklig. Inst. Mining and Metallurgy. *Oil News* **12**, 1231, 1260.

CORE DRILLING IN THE CALIFORNIAN OILFIELDS.—J. E. Elliott and F. C. Merritt. *Petr. Times* **8**, 689.

DIAMOND DRILLING FOR OIL.—*Petr. World* **19**, 445.

IMPROVED CIRCULATING AND CASING HEAD.—*Oil Engineering and Finance* **2**, 603.

PATENTS.

EXCLUDING WATER FROM OIL AND GAS WELLS.—D. V. Mills. U.S. Pat. 1,421,706. *Chem. Abstr.* **16**, 2987.

APPARATUS FOR BORING PETROLEUM AND FOR BALING.—W. Zimmermann. Ger. Pat. 355,285. *Oil Engineering and Finance* **2**, 438.

SELF-ACTING FISHING TOOLS FOR CLEARING BORINGS.—F. Buhmann. Ger. Pat. 354,393. *Oil Engineering and Finance* **2**, 443.

4. Pipe Lines, Transport and Storage.

Buried Steel Tanks for Fuel Oil: an Investigation of Longevity. —*Am. Architect*, Jn. 21.

Concrete Tanks for Oil Storage.—*Oil Engineering and Finance* **2**, 368.

Measurement of Gas and Liquids by Orifine Meter.—H. P. Westcott and J. C. Diehl. Metric Metal Works, Erie, Pa. (2nd Edition.)

Durable Foam Seal Stops Evaporation and Reduces Fire Risk.—P. Pruesdell. *Nat. Petr. News* **14**, (28), 43. *Chem. Abstr.* **16**, 3200.

Fuel Storage.—O. Heinrich. *Arch. Wärmewirtschaft* **3**, 132. *Chem. Abstr.* **16**, 3376.

Evolution in Oil Transport.—*Petr. Age* **10**, (7), 15.

The Oil Tanker.—C. R. H. Bonn. Assoc. of Engineering and Shipbuilding Draughtsmen.

A Novel Pipe Line Strainer.—*Oil News* **12**, 1204.

Gasoline Vapour Loss Costly.—*Petr. Age* **10**, (8), 78.

Fire and Explosion Hazards of Petroleums and Petroleum Products. —N. A. C. Smith and S. H. Katz. *U.S. Bur. Mines Rept. Oil Engineering and Finance* **2**, 549, 575, 604.

Memorandum and Draft Regulations in Connection with the Bulk Storage of Petroleum Products.—*H.M. Petroleum Dept. Bull.* 2. H.M. Stationery Office.

The Flow of Liquids in Pipes.—N. Swindin. Benn Bros., London.

Patents.

Stable Foam for Preventing the Evaporation of Stored Liquids.—J. M. Jennings. Assr. to Standard Oil Co. U.S. Pat. 1,423,719-21. *J. Soc. Chem. Ind.* **41**, 697A. *Chem. Abstr.* **16**, 3202.

Sealing Composition Impervious to Gasoline.—M. I. Strause. U.S. Pat. 1,423,821. *Chem. Abstr.* **16**, 3178.

Receptacle for Gasoline.—C. A. Cleghorn. U.S. Pat. 1,422,670. *Chem. Abstr.* **16**, 3203.

5. Refinery Technique.

Methods for Recovering Gasoline from Uncondensed Still Vapours. —D. B. Dow. *U.S. Bur. Mines Repts. Investigations* 2344. *Nat. Petr. News* **14**, (22), 28; (23), 87. *Chem. Abstr.* **16**, 2776.

Double-run Back Line Would Save Loss to the Small Refiner.—K. M. Doan. *Nat. Petr. News* **14**, (23), 43. *Chem. Abstr.* **16**, 2777.

The Refining of Gasoline and Kerosene by Hypochlorite Solutions. —A. E. Dunstan and B. T. Brooks. Amer. Chem. Soc. *Petr. Times* **8**, 424. *Petr. World* **19**, 428.

Refining of Cracked Hydrocarbon Oils.—J. C. Morrell and G. Egloff. —Amer. Chem. Soc. *Petr. Times* **8**, 461. *Petr. World* **19**, 429.

Wax Extraction by Centrifugal Force.—W. Miller. *Oil and Gas J.* **21**, (7), 14.

Vacuum Distillation of Oil.—W. L. Gomory. *Petr. Age* **10**, (7), 117.

The Purification of Naphthenic Acids.—F. Zernik. *Z. angew. Chem.* **35**, 566.

A Simple Graphical Method for Calculating the Number of Plates Required for a Distilling Column.—W. H. Rodebush. *J. Ind. Eng. Chem.* **14**, 1036.

Cylinder Oil from Oklahoma Crude.—F. T. Franks. *Oil and Gas J.* **21**, (14), 14. *Chem. Abstr.* **16**, 3541.

Proposed Method for Mining Oil Sands.—M. A. Newman. *Petr. Times* **8**, 284. *Chem. Abstr.* **16**, 3541.

Problems of the Oil Refiner.—*Petr. Age* **10**, (9), 15.

Patents.

Bituminous Material from Wax Tailings.—L. Kirschbraun. U.S. Pat. 1,417,838. *Chem. Abstr.* **16**, 2766.

Treating Oil-bearing Sand.—G. Schneiders. U.S. Pat. 1,418,098. *Chem. Abstr.* **16**, 2778.

Separating Petroleum-oil Sludges.—S. H. Diggs. U.S. Pat. 1,418,781. *Chem. Abstr.* **16**, 2779.

Distillation of (Hydrocarbon) Oils.—Trent Process Corp. Assees. of W. E. Trent. Brit. Pat. 171,075. *J. Soc. Chem. Ind.* **41**, 701A.

Means for Desulphurising Oils (*e.g.* Shale Oil).—A. C. Nesfield. Brit. Pat. 183,527. *J. Soc. Chem. Ind.* **41**, 701A. *Petr. Times* **8**, 498.

Process for Desulphurising (Mineral) Oil. Process for Obtaining Sulphur Compounds from Mineral Oils and the Like. Method of Desulphurising Oil.—J. C. Clancy. Assr. to The Nitrogen Corp. U.S. Pat. 1,423,710–2. *J. Soc. Chem. Ind.* **41**, 701A. *Chem. Abstr.* **16**, 3202.

Method of Treating Sludge Acids (from Refining of Mineral Oils). —I. Hechenbleikner and T. C. Oliver. Assrs. to Chemical Construction Co. U.S. Pat. 1,423,766. *J. Soc. Chem. Ind.* **41**, 702A. *Chem. Abstr.* **16**, 3203.

Treating Sludge Acids. I. Hechenbleikner and T. C. Oliver. U.S. Pat. 1,421,688. *Chem. Abstr.* **16**, 2987.

Separating Aluminium Chloride from Heavy Hydrocarbons.—C. O. Hoover. Assr. to The Hoover Co. U.S. Pat. 1,426,081. *J. Soc. Chem. Ind.* **41**, 741A.

Purifying Hydrocarbons.—J. Demant. Brit. Pat. 179,610. *Chem. Abstr.* **16**, 3387.

AN IMPROVED REFINING PROCESS.—A. E. Dunstan. Brit. Pat. 184,281. *Petr. Times* **8**, 642. *J. Soc. Chem. Ind.* **41**, 741A.

PROCESS FOR REFINING MINERAL OILS AND THE LIKE.—Plauson's Forschungs-institut. Ger. Pat. 352,189. *J. Soc. Chem. Ind.* **41**, 802A.

PROCESS FOR THE PURIFICATION OF HYDROCARBON OILS.—Deutsche Erdöl A.-G. Ger. Pat. 352,917. *J. Soc. Chem. Ind.* **41**, 802A.

CONTINUOUS PRODUCTION OF PARAFFIN.—W. Scheffler. Ger. Pat. 353,780. *J. Soc. Chem. Ind.* **41**, 802A.

PROCESS FOR CLEANING (REMOVING INORGANIC SALTS FROM) SULPHONIC ACID (FROM MINERAL OILS).—A. Wolff. Assr. to The Chemical Foundation, Inc. U.S. Pat. 1,428,197. *J. Soc. Chem. Ind.* **41**, 802A.

METHOD OF REFINING MINERAL OILS OBTAINED FROM EARTH OIL.—C. R. Ehlers. Brit. Pat. 184,991.

PROCESS FOR TREATMENT OF WASTE SULPHURIC ACID (FROM REFINING TAR OILS) TO RECOVER RESINOUS PRODUCTS.—S. Hilpert. Assr. to Deutsche Luxemburgische Bergwerks und Hütten A.-G. U.S. Pat. 1,427,386. *J. Soc. Chem. Ind.* **41**, 803A.

DESULPHURISING PETROLEUM AND SIMILAR OIL.—W. R. Walkey and A. F. Bargate. Brit. Pat. 186,738. *Chem. Age* **7**, 682.

EXTRACTION OF NAPHTHASULPHONIC ACIDS PRODUCED IN THE REFINING OF MINERAL OILS WITH ACIDS.—Oelwerke Stern-Sonneborn A.-G. Ger. Pat. 310,701. *J. Soc. Chem. Ind.* **41**, 850A.

METHOD OF TREATING SLUDGE ACIDS.—I. Hechenbleikner and T. C. Oliver. Assrs. to Chemical Construction Co. U.S. Pat. 1,429,140. *J. Soc. Chem. Ind.* **41**, 851A.

DEHYDRATOR (FOR PETROLEUM EMULSIONS).—F. W. Harris. Assr. to Petroleum Rectifying Co. U.S. Pat. 1,430,300.

TREATMENT OF PETROLEUM AND PETROLEUM DISTILLATES.—A. E. Dunstan and F. B. Thole. Brit. Pat. 186,955. *Chem. Age* **7**, 714.

PROCESS AND MACHINE FOR REFRIGERATION.—W. Stewart. Brit. Pat. 185,607. *J. Soc. Chem. Ind.* **41**, 846A.

6. NATURAL GAS.

RECORDING AND INTEGRATING GAS CALORIMETER.—C. V. Boys. *Gas World* **76**, 581. *Gas J.* **158**, 882. *Chem. Abstr.* **16**, 2772.

RECORDING CALORIFIC VALUE OF GAS. THE FAIRWEATHER RECORDING CALORIMETER.—*Gas World* **77**, 12. *Chem. Abstr.* **16**, 2773.

CARBON BLACK PRODUCED FROM NATURAL GAS IN 1921.—E. G. Sievers. *Mineral Resources of U.S.* 1921, Part II., 33.

DESIGN AND OPERATION OF A LOW-PRESSURE ABSORPTION PLANT.—W. P. Dykema and A. A. Chenoweth. *U.S. Bur. Mines Tech. Paper* 263. *Oil Engineering and Finance* **2**, 102. *Petr. Times* **8**, 177, 317, 537. *Petr. World* **19**, 357. *J. Soc. Chem. Ind.* **41**, 799A.

CARBON BLACK—ITS MANUFACTURE, PROPERTIES AND USES.—R. O. Neal and G. St. J. Perrott. *U.S. Bur. Mines Bull.* 192. *Chem. Abstr.* **16**, 3174. *J. Soc. Chem. Ind.* **41**, 770A.

THE PRESENCE OF CARBON MONOXIDE IN THE NATURAL GAS FROM PETROLEUM.—E. Schmitz. *Mat. grasses* **14**, 6157. *Chem. Abstr.* **16**, 3193.

THE ABSORPTION OF GASOLINE FROM NATURAL GAS. PART II.—R. C. Cantelo. *Canad. Chem. and Met.* **6**, 196.

METHANE: PROPERTIES, CONSTANTS AND USE.—J. Bronn. *Chem. Zeit.* **46**, 926.

COMPOSITION OF JAPANESE NATURAL GAS.—T. Ohno. *Kogyo Kwakaku (J. Chem. Ind. Japan)* **25**, 783. *J. Soc. Chem. Ind.* **41**, 799A.

COMBUSTION OF GASEOUS FUELS JUDGED FROM GAS ANALYSES.—A. G. Witting. *Amer. Gas Journal* **117**, (12), 250, 256.

CONDENSATION OF VAPOUR FROM MIXTURES OF VAPOURS AND NON-CONDENSABLE GAS.—B. F. Dodge. *J. Ind. Eng. Chem.* **14**, 1063.

PATENTS.

LAMPBLACK.—W. K. Lewis. U.S. Pat. 1,418,811. *Chem. Abstr.* **16**, 2760.

LAMPBLACK AND HYDROGEN.—H. J. Masson. U.S. Pat. 1,418,385. *Chem. Abstr.* **16**, 2760.

SCRUBBING APPARATUS FOR RECOVERING GASOLINE FROM CASINGHEAD GAS. W. R. McGinnis. U.S. Pat. 1,418,870. *Chem. Abstr.* **16**, 2779.

RECOVERING VAPOURS FROM GAS MIXTURES.—C. L. Voress and C. C. Canter. U.S. Pat. 1,420,613. *Chem. Abstr.* **16**, 2944.

PRODUCTION OF CARBON.—W. E. F. Bradley. U.S. Pat. 1,426,144. *J. Soc. Chem. Ind.* **41**, 740A.

PROCESS OF TREATING NATURAL GAS AND PRODUCT THEREOF.—H. E. Thompson. Assr. to Carbide and Carbon Chemical Corp. U.S. Pat. 1,429,175. *J. Soc. Chem. Ind.* **41**, 849A.

7. PETROL AND OTHER MOTOR FUELS.

FURTHER DATA ON THE MEASUREMENT OF THE EFFECTIVE VOLATILITY OF MOTOR FUELS.—R. E. Wilson and D. P. Barnard. Am. Chem. Soc. *Petr. Times* **8**, 423.

THE APPLICATION OF CHEMISTRY TO THE CONSERVATION OF MOTOR FUELS.—T. Midgley, Jr., and T. A. Boyd. *J. Ind. Eng. Chem.* **14**, 849. *Chem. Abstr.* **16**, 3380.

ENGINE EXPERIMENT WITH HIGH SULPHUR FUELS.—C. O. Johns. Am. Chem. Soc. *Petr. World* **19**, 428.

GASOLINE SAVED ON GOVERNMENT TRUCKS.—G. W. Jones and A. C. Fieldner. Am. Chem. Soc. *Petr. World* **19**, 428.

POWER ALCOHOL AS A FUEL FOR EGYPT.—C. W. Wood. *Cairo Sci. Jour.* **10**, 9. *Chem. Abstr.* **16**, 2978.

CARBURETTOR ADJUSTMENT BY GAS ANALYSIS.—A. C. Fieldner and G. W. Jones. *J. Ind. Eng. Chem.* **14**, 594. *Chem. Abstr.* **16**, 2978.

RECENT RESEARCH WORK ON THE INTERNAL-COMBUSTION ENGINE.—H. R. Ricardo. *J. Soc. Automotive Eng.* **10**, 305. *Chem. Abstr.* **16**, 2978.

THE BETTER UTILISATION OF MOTOR SPIRIT.—*Petr. Times* **8**, 524.

THE COMBUSTION OF FUELS IN THE INTERNAL-COMBUSTION ENGINE. T. Midgley, Jr. *J. Soc. Auto. Eng.* **7**, 489. *Expt. Sta. Record.* **44**, 786. *Chem. Abstr.* **16**, 3192.

ALCOHOL AS A MOTOR FUEL.—*J. Soc. Auto. Eng.* **10**, 364. *Chem. Abstr.* **16**, 3193.

RAPID EVALUATION OF MOTOR FUELS.—*Chem. Fabr. A.-G. J. Soc. Chem. Ind.* **41**, 421B.

MOTOR FUEL FROM MAIZE.—*S. Afr. J. Ind.* (*Aug.*). *J. Soc. Chem. Ind.* **41**, 422B.

THE CHEMICAL CONTROL OF GASEOUS DETONATION WITH PARTICULAR REFERENCE TO THE INTERNAL-COMBUSTION ENGINE.—T. Midgley, Jr., and T. A. Boyd. *J. Ind. Eng. Chem.* **14**, 894.

A NEW PRODUCT (SUPER-GAS).—*U.S. Commerce Repts., Aug., p.* 530.

SIXTH SEMI-ANNUAL MOTOR GASOLINE SURVEY.—A. D. Bauer and N. F. Le Jeune. *U.S. Bur. Mines Repts. Investigations* 2388.

A STUDY OF MIXTURES OF PETROL AND ALCOHOL.—Guinot. International Oil Congress, Paris. *Oil Engineering and Finance* **2**, 488.

SCIENTIFIC ORGANISATION OF THE CONGRESS HELD AT BEZIERS FOR A NATIONAL MOTOR SPIRIT.—Godechet, Pasquet, Robert and Gas. International Oil Congress, Paris. *Oil Engineering and Finance* **2**, 488.

HOT SPOT METHOD OF HEAVY FUEL PREPARATION.—F. C. Mack and M. E. Chandler. *J. Soc. Auto. Eng.* **11**, 27. *Chem. Abstr.* **16**, 3379.

A (FRENCH) NATIONAL MOTOR FUEL AND THE DISTILLATION INDUSTRY.—Mariller. *Chim. et Ind.* **7**, 1071. *Chem. Abstr.* **16**, 3379.

THE CRANK CASE OIL DILUTION PROBLEM AND ITS SOLUTION.—W. F. Parish. *J. Soc. Auto. Eng.* **11**, 35. *Chem. Abstr.* **16**, 3380.

PROBLEMS INVOLVED IN THE DEVELOPMENT OF SPECIFICATIONS FOR MOTOR GASOLINE.—E. W. Dean. *Proc. Am. Soc. Testing Materials* **21**, 1094. *Chem. Abstr.* **16**, 3387.

"MILEAGE" AND "ANTI-KNOCK" COMPOUNDS.—*Petr. Times* **8**, 640.

ON TYPES OF MOTOR FUELS.—*Petr. Age* **10**, (8), 18.

PATENTS.

LIQUID FUEL MIXTURE.—A. A. Backhaus. U.S. Pat. 1,419,910. *Chem. Abstr.* **16**, 2774.

INTERNAL-COMBUSTION ENGINE FUEL.—M. C. Whitaker. U.S. Pat. 1,420,007. *Chem. Abstr.* **16**, 2774.

FUEL FOR USE IN INTERNAL-COMBUSTION ENGINES.—H. R. Ricardo. Brit. Pat. 183,577. *J. Soc. Chem. Ind.* **41**, 701A.

FUEL OF LIQUID TYPE. LIQUID FUEL.—B. R. Tunison, Assr. to U.S. Industrial Alcohol Co. U.S. Pat. 1,423,048-50. *J. Soc. Chem. Ind.* **41**, 701A. *Chem. Abstr.* **16**, 3195.

LIQUID FUEL MIXTURE.—E. A. Charbonneaux. U.S. Pat. 1,420,622. *Chem. Abstr.* **16**, 2982.

LIQUID FUEL.—M. C. Whitaker. U.S. Pat. 1,421,879. *Chem. Abstr.* **16**, 2982.

FUEL.—J. Penhale. Brit. Pat. 178,373. *Chem. Abstr.* **16**, 3195.

FUEL FOR INTERNAL-COMBUSTION ENGINES.—M. C. Whitaker. U.S. Pat. 1,423,058. *Chem. Abstr.* **16**, 3195.

MOTOR FUEL.—F. W. Rohrs. U.S. Pat. 1,425,135. *J. Soc. Chem. Ind.* **41**, 741A. *Chem. Abstr.* **16**, 3384.

FUEL.—R. V. Jubany. Brit. Pat. 180,287. *Chem. Abstr.* **16**, 3384.

LIQUID FUEL.—W. T. Schreiber. Can. Pat. 221,090. *Chem. Abstr.* **16**, 3384.

MOTOR SPIRIT.—S. W. Blake. Brit. Pat. 178,498. *Chem. Abstr.* **16**, 3384.

AEROPLANE MOTOR FUEL.—W. T. Schreiber, Assr. to U.S. Industrial Alcohol Co. U.S. Pat. 1,428,913.

MOTOR FUEL. R. V. Jubany. Brit. Pat. 180,622. *Chem. Abstr.* **16**, 3540.

METHOD OF FORMING A LIQUID FUEL.—A. Hayes, Assr. to U.S. Industrial Co. U.S. Pat. 1,428,885. *J. Soc. Chem. Ind.* **41**, 850A.

MANUFACTURES OF ALCOHOL ETHER MIXTURES.—H. Wade. From F. E. Lichtenthaler. Brit. Pat. 187,051–2. *Chem. Age* **7**, 715.

LUBRICANTS AND LUBRICATION.

LUBE OILS; THEIR MANUFACTURE.—*Petr. Age* **10**, (5), 15.

SULPHO-ACID BODIES IN LUBRICATING OILS.—G. L. Oliensis. Am. Chem. Soc. *Petr. Times* **8**, 424. *Petr. World* **19**, 429.

INDUSTRIAL OIL ENGINEERING, LUBRICATION AND INDUSTRIAL OIL SECTION.—J. R. Battle. J. B. Lippincott, Philadelphia and London.

LUBRICANT AND ASPHALTIC HYDROCARBONS IN PETROLEUM.—C. F. Mabery. Am. Chem. Soc. *Petr. Times* **8**, 461. *Petr. World* **19**, 429.

THICKNESS AND RESISTANCE OF OIL FILMS IN HIGH-SPEED BEARINGS.—G. Stoney, R. O. Boswall and J. Massey. *Engineering* **113**, 249. *Chem. Abstr.* **16**, 2943.

MECHANICAL LUBRICATORS.—A. B. Smith. Diesel Engine Users' Assoc. (Feb. 10). *Chem. Abstr.* **16**, 2943.

EFFECT OF SUPERHEATED STEAM ON CYLINDER LUBRICATION.—W. F. Osborne. *Power* **56**, 352. *Oil Engineering and Finance* **2**, 379.

ON REFINING LUBRICATING OILS.—*Petr. Age* **10**, (6), 15.

How to Find the Proper Oil for a Circulating System.—W. F. Osborne. *Power* (*July* 4).

Problems of the Lubrication Engineer.—W. F. Parish. *International Steam Engineer* (*June* 22).

Temperature Coefficient (of Boundary Lubrication).—W. B. Hardy and I. Doubleday. *Proc. Roy. Soc.* A **101**, 487. *J. Soc. Chem. Ind.* **41**, 739A.

The Lubrication of Heavy Oil Engines. H. Moore. International Oil Congress, Paris. *Oil Engineering and Finance* **2**, 525.

How and Why Oils must be Cleaned and Filtered while in Use.—W. F. Osborne. *Power* (*June* 13).

Oil Film on Cylinder Walls.—W. F. Osborne. *Power* (*Aug.* 22).

Present Position of the Theory of Lubrication.—Gümbel. *Forschungsarb. Geb. Ingenieurw.* **1920**, 3. *Chem. Abstr.* **16**, 3518.

Patents.

Transmission and Motor Oil.—W. K. Boileau, Assr. to Pittsburg Oil Refining Corp. U.S. Pat. 1,423,512. *J. Soc. Chem. Ind.* **41**, 702A. *Chem. Abstr.* **16**, 3149.

Purifying Apparatus for Lubricating Oils.—E. E. Hans. U.S. Pat. 1,420,837. *Chem. Abstr.* **16**, 2987.

Emulsifying Agent for Liquids Insoluble in Water.—K. Daimler and Farbw. vorm. Meister, Lucius und Brüning. Ger. Pat. 352,860. *J. Soc. Chem. Ind.* **41**, 742A.

Process of Increasing the Consistency of Hydrocarbon Oils and Other Oils and Fats.—H. Meyer and O. Koedrich. Brit. Pat. 185,782. *Chem. Age* **7**, 568.

Production of Highly Viscous Lubricating Oils, Leather Grease, Artificial Vaseline, Lanolin-Like Materials, and the Like, from Mineral, Vegetable and Animal Oils.—Plauson's Forschungsinstitut G.m.b.H. Ger. Pat. 353,222. *J. Soc. Chem. Ind.* **41**, 826A.

Manufacture of Viscous Oily Compositions and Treatment of Waxes for Use therein.—Plauson's (Parent) Co., Ltd. Brit. Pat. 186,950. Chem. Age **7**, 714.

Fuel Oil.

A New Fuel Oil Burner.—A. Grounds. *Oil Engineering and Finance* **2**, 284.

Liquid Fuels.—Part III. M. Verneuil. *L'Ind. Chim.* (*Sept.*), 378.

Liquid Fuel and its Apparatus.—W. H. Booth. (Second edition.) E. P. Dutton and Co., New York.

Distribution of Fuel Oil in Industrial Plants.—J. A. Brown. *Forging and Heat Treating* **8**, (8), 336.

Effects of Sulphur in Fuel Oil.—A. F. Brewer. *Power* **55**, 50. *Chem. Abstr.* **16**, 3379.

PATENT.

LIQUID FUEL.—C. J. Greenstreet. Brit. Pat. 179,567. *Chem. Abstr.* **16**, 3384.

DIESEL OIL AND ENGINES.

PALM OIL AS A MOTOR FUEL.—*Bull. Imp. Inst.* **19**, 515. *Chem. Abstr.* **16**, 2769.

ENGINE EXPERIMENTS WITH HIGH SULPHUR FUELS.—C. O. Johns. Am. Chem. Soc. *Petr. Times* **8**, 424.

SOME CHARACTERISTICS OF PETROLEUM OILS USED ON DIESEL ENGINES.—H. Moore. *Diesel Engine Users' Assoc.* (*April* 7). *Chem. Abstr.* **16**, 2984.

THE COMPRESSORLESS DIESEL ENGINE.—K. Rodzich. *Wärme u. Kalte Technik* **24**, 103. *Chem. Abstr.* **16**, 3380.

THE SUPPLY OF FUEL OIL.—J. V. Stevens. *Oil Engineering and Finance* **2**, 501.

CARE AND MAINTENANCE OF DIESEL ENGINES.—G. E. Windeler. *Diesel Engine Users' Assoc. Petr. World* **19**, 469.

PLANT AND MACHINERY.

THE USE OF SUPER-CENTRIFUGES.—R. Berline. International Oil Congress. Paris. *Oil Engineering and Finance* **2**, 476.

PATENTS.

SEPARATING AND TOPPING HYDROCARBONS FROM AQUEOUS MIXTURES.—W. A. Brown. U..S Pat. 1,419,610. *Chem. Abstr.* **16**, 2778.

FRACTIONAL CONDENSATION OF HYDROCARBONS OR SIMILAR SUBSTANCES.—J. F. W. Schulze. U.S. Pat. 1,418,885. *Chem. Abstr.* **16**, 2778.

APPARATUS FOR FRACTIONATING PETROLEUM OILS OR RESIDUUMS.—L. Clark. U.S. Pat. 1,418,621. *Chem. Abstr.* **16**, 2779.

OIL HEATER FOR TOPPING STILLS.—J. E. Bell. U.S. Pat. 1,418,272.

DISTILLING COLUMN.—F. E. Lichtenthaeler, Assr. to W. E. Lummus Co. U.S. Pat. 1,424,173. *J. Soc. Chem. Ind.* **41**, 697A. *Chem. Abstr.* **16**, 3237.

PROCESS OF FRACTIONATION OF VOLATILE AND MORE ESPECIALLY EASILY VOLATILE LIQUID MIXTURES.—"Metan," Spolka z. ograniczona odp. Ger. Pat. 351,082. *J. Soc. Chem. Ind.* **41**, 698A.

FRACTIONAL DISTILLATION OF CRUDE OIL. APPARATUS FOR DISTILLING CRUDE OIL AND OTHER LIQUIDS.—P. Mather. Brit. Pat. 182,827. *J. Soc. Chem. Ind.* **41**, 701A.

STILLS FOR CONTINUOUS DISTILLATION OF COAL TAR, MINERAL OILS, AND THE LIKE.—J. A. Yeadon. Brit. Pat. 183,682. *J. Soc. Chem. Ind.* **41**, 703A.

PROCESS AND APPARATUS FOR DISTILLING OILS.—J. T. Fenton. U.S. Pat. 1,424,998. *J. Soc. Chem. Ind.* **41**, 741A. *Chem. Abstr.* **16**, 3388.

DAMPER CONTROL FOR OIL STILLS.—J. Primrose, Assr. to Power Specialty Co. U.S. Pat. 1,425,896. *J. Soc. Chem. Ind.* **41**, 742A.

PROCESS AND APPARATUS FOR DISTILLING TAR AND OTHER LIQUIDS.—W. W. Glossop, L. Bradley and R. P. Willsdon. Brit. Pat. 184,242. *J. Soc. Chem. Ind.* **41**, 743A.

PROCESS FOR DEHYDRATING EMULSIONS OF TARS AND OILS.—Badische Anilin- und Soda-Fabrik. Ger. Pat. 354,202. *J. Soc. Chem. Ind.* **41**, 743A.

SEPARATING CONSTITUENTS OF EMULSIONS.—Metcalf-Shaw Corp. Brit. Pat. 179,194. *Chem. Abstr.* **16**, 3353.

RESOLVING EMULSIONS.—Sharples Specialty Co. Brit. Pat. 180,447. *Chem. Abstr.* **16**, 3354.

PROCESS FOR THE MANUFACTURE OF OILY PASTES OR EMULSIONS FROM MINERAL AND OTHER OILS.—Plauson's (Parent Co.). (From) H. Plauson. Brit. Pat. 185,779. *Chem. Age* **7**, 568.

HEAT-EXCHANGE APPARATUS; DISTILLING OILS.—T. E. Robertson. Brit. Pat. 179,493. *Chem. Abstr.* **16**, 3237.

APPARATUS FOR WASHING OIL-PURIFYING MATERIAL OR OTHER INSOLUBLE POWDERS.—P. W. Prutzman. U.S. Pat. 1,426,099. *Chem. Abstr.* **16**, 3237.

SEPARATING LIQUIDS.—W. H. Bateman. Brit. Pat. 179,209. *Chem. Abstr.* **16**, 3353.

DISTILLATION OF TAR. THERMAL, INDUSTRIAL AND CHEMICAL (T. I. C.) RESEARCH CO.—J. S. Morgan and D. Rider. Brit. Pat. 184,624. *J. Soc. Chem. Ind.* **41**, 303A.

STILLS.—A. C. Jewell. Brit. Pat. 185,451.

DISTILLING AND RECTIFYING COLUMN.—E. A. Barbet. U.S. Pat. 1,427,430.

VAPORISERS AND STEAM-GENERATORS.—W. H. Caldwell. Brit. Pat. 178,871. *Chem. Abstr.* **16**, 3416.

SETTINGS FOR STILLS AND FOR SIMILAR PURPOSES.—F. Mather. Brit. Pat. 186,849. *Chem. Age* **7**, 683.

ELECTRICAL DEHYDRATOR FOR OIL EMULSIONS.—W. Meredith, Assr. to Petroleum Rectifying Co. U.S. Pat. 1,428,178. *J. Soc. Chem. Ind.* **41**, 850A.

APPARATUS FOR TREATING NATURAL EMULSIONS OF PETROLEUM.—W. S. Barnickel. U.S. Pat. 1,428,204. *J. Soc. Chem. Ind.* **41**, 850A.

OIL-TOPPING PLANT.—B. Gallsworthy. U.S. Pat. 1,428,159. *J. Soc. Chem. Ind.* **41**, 850A.

TESTING, ANALYSIS AND APPARATUS.

NEW APPARATUS FOR INVESTIGATING PARAFFINS, WAXES, RESINS, PITCHES AND ASPHALTS. *Chem.-Zeit.* **46**, 386. *Chem. Abstr.* **16**, 2623.

THE DETERMINATION OF SURFACE TENSION FROM THE MAXIMUM PRESSURE IN BUBBLES.—S. Sugden. *J. Chem. Soc.* **121**, 858. *Chem. Abstr.* **16**, 2627.

PETROLEUM COLORIMETRY.—P. D. Barton. *Nat. Petr. News* **14**, (22), 53. *Chem. Abstr.* **16**, 2776.

A RAPID TEST FOR THE DECOLORISING EFFICIENCY OF FULLERS' EARTH.—L. W. Parsons and L. R. Churchill. Am. Chem. Soc. *Petr. Times* **8**, 423. *Petro. World* **19**, 427.

SOME FACTORS AFFECTING THE ACCURACY OF SAYBOLT VISCOSITY MEASUREMENT AND THEIR CONTROL.—P. E. Klopsteg and W. H. Stannard. Am. Chem. Soc. *Petr. Times* **8**, 424. *Petr. World* **19**, 428.

FRACTIONAL DISTILLATION OF VARIOUS PETROLEUM UNDER REDUCED PRESSURE WITH NEW TYPE RECEIVER.—J. C. Morrell and G. Egloff. Am. Chem. Soc. *Petr. Times* **8**, 461. *Petr. World* **19**, 429.

MEASUREMENT OF THE EFFECTIVE VOLATILITY OF MOTOR FUELS.—R. E. Wilson and D. P. Barnard. Am. Chem. Soc. *Petr. World* **19**, 427.

APPARATUS FOR DETERMINING THE VOLATILITY, BLISTERING AND ADHESION OF ASPHALT ON METAL.—J. W. H. Uytenbogaart, Jr. *Chem. Zeit.* **46**, 565. *Chem. Abstr.* **16**, 2797.

THE DRACORUBIN TEST OF HYDROGENATED COMPOUNDS.—W. Schrauth and O. von Keussler. *Auto-Technik.* **10**, (17), 3. *Chem. Abstr.* **16**, 2984.

THE STANDARDISATION OF METHODS FOR TESTING LUBRICATING OILS AND ALLIED SUBSTANCES.—H. Moore. *Oil Engineering and Finance* **2**, 395.

THE USE OF COMMERCIAL VISCOSIMETERS.—H. Gault and L. Boisselet. *Mat. grasses* **14**, 6185. *Chem. Abstr.* **16**, 3013.

VISCOSITY DETERMINATIONS BY MEANS OF ORIFICES AND SHORT TUBES.—W. N. Bond. *Proc. Phys. Soc., London* **34**, 139. *Chem. Abstr.* **16**, 3020.

APPARATUS FOR DETERMINING RESISTANCE TO COLD OF MINERAL OILS.—K. Glaser. *Petroleum* **18**, 81. *Chem. Abstr.* **16**, 3199.

COLOUR OF PETROLEUM MIXTURES AND PARAFFIN WAX.—M. Bomberg. *Petroleum* **18**, 361. *Chem. Abstr.* **16**, 3200.

TECHNICAL EXAMINATION OF LUBRICATING OIL AND GREASE.—F. W. Watson and H. D. Bell. *J. Chem. Met. and Min. Soc., South Africa* **22**, (11), 211.

THE EFFECT OF VARIATION IN THE WEIGHT OF THE RIDERS AND PLUMMETS OF THE WESTPHAL BALANCE UPON THE ACCURACY OF SPECIFIC-GRAVITY DETERMINATIONS.—E. A. Tschudy. *J. Amer. Chem. Soc.* **44**, 2130.

A SIMPLE AND QUICK METHOD FOR THE DETERMINATION OF THE SURFACE TENSION OF SMALL QUANTITIES OF A LIQUID.—R. Brinkman and E. van Dam. Nederland Tijdschr. Genees-Kunde **65**, II., 2905.

EXAMINATION OF HYDROCARBON OILS, SAPONIFIABLE FATS AND WAXES.—D. Holde. Trans. from Fifth Edition by E. Mueller. J. Wiley & Sons, Inc., New York.

FRACTIONAL DISTILLATIONS OF FUELS AND HOW TO MAKE THEM.—P. S. Tice. *Auto. Industries* (July 29).

EXAMINATION OF PARAFFIN WAX AND VASELINE.—E. Pyhälä. *Petroleum* **18**, 1164. *J. Soc. Chem. Ind.* **41**, 800A. *Oil Engineering and Finance* **2**, 398.

EXAMINATION OF BORING AND COOLING OILS (SOLUBLE OILS).—T. Kaleta. *Chem. Zeit.* **46**, 783. *J. Soc. Chem. Ind.* **41**, 800A.

GASOLINE CONTENT OF PARAFFIN CRUDE. DETERMINATION AND APPLICATION.—L. B. Beech. *Nat. Petr. News* **14**, (35), 33. *Chem. Abstr.* **16**, 3541.

THE MICHELL VISCOMETER.—*Petr. Times* **8**, 710.

PYCNOMETER DENSITY DETERMINATIONS.—R. Saar. *Chem. Zeit.* **46**, 433.

DETERMINATION OF VOLATILITY OF OILS.—A. R. Matthis. *Bull. Fed. Ind. Chem. Belg.* **1**, 397. *J. Soc. Chem. Ind.* **41**, 699A.

PATENTS.

DISTILLING HEAD FOR LABORATORY APPARATUS, ETC.—P. Anders and P. M. Ginnings. U.S. Pat. 1,418,691.

HYDROMETER.—C. E. Linebarger. U.S. Pat. 1,424,730. *Chem. Anstr.* **16**, 3237.

CRACKING AND HYDROGENATION.

CRACKING OF UNSATURATED HYDROCARBONS BY HEAT TO GIVE SATURATED HYDROCARBONS.—R. H. McKee and R. T. Goodwin. Am. Chem. Soc. *Petr. Times* **8**, 424. *Petr. World* **19**, 428.

THE MCAFEE DISTILLATION PROCESS.—*Petr. Times* **8**, 447.

CRACKING PETROLEUM.—K. Smolénski, S. Turowicz and T. Dobroweski *Przemysl Chem.* **5**, 201, 237. *Chem. Abstr.* **16**, 2984.

FLEMING PROCESS IS FOUND SUCCESSFUL BY STERLING O. AND R. CO.—V. B. Guthrie. *Nat. Petr. News* **14**, (26), 23. *Chem. Abstr.* **16**, 3201.

PROCESS IN SYNTHETIC GASOLINE PRODUCTION.—R. Cross. *Mech. Engineering.*

DECOMPOSITION OF AROMATIC COMPOUNDS FROM COAL. *Petr. Times* **8**, 750.

THE MANUFACTURE OF PETROLEUM PRODUCTS.—G. A. Burrell. *Oil Gas J.* **20**, (50), 14. *Chem. Abstr.* **16**, 2776.

THE PRODUCTION OF GASOLINE BY CRACKING HEAVIER OILS.—E. W. Dean and W. A. Jacobs. *U.S. Bur. Mines Tech. Paper* 258. *Chem. Abstr.* **16**, 2776.

USE OF CALORISED TUBES IN OIL REFINING.—A. V. Farr. *Nat. Petr. News* **14**, (22), 83. *Chem. Abstr.* **16**, 2777.

PATENTS.

PROCESS FOR PRODUCING GASOLINE AND THE LIKE.—J. C. Clancy. Assr. to The Nitrogen Corp. U.S. Pat. 1,423,709. *J. Soc. Chem. Ind.* **41**, 702A. *Chem. Abstr.* **16**, 3202.

Treatment of Hydrocarbons.—H. Plauson. Can. Pat. 220,514. *Chem. Abstr.* **16**, 2986.

Cracking Hydrocarbon Oils.—D. T. Day. U.S. Pat. 1,422,038. *Chem. Abstr.* **16**, 2986.

Cracking Oils.—R. D. George. U.S. Pat. 1,420,832. *Chem. Abstr.* **16**, 2986.

Cracking Petroleum Hydrocarbons.—R. Cross. U.S. Pat. 1,423,500. *Chem. Abstr.* **16**, 3202.

Motor Fuel from Petroleum.—O. P. Amend. U.S. Pat. 1,423,064. *Chem. Abstr.* **16**, 3202.

Fuel Oils.—R. H. Brownlee and C. F. de Ganahl. Brit. Pat. 177,589. *Chem. Abstr.* **16**, 3202.

Cracking Petroleum Oil.—R. E. Hanna. U.S. Pat. 1,419,378. *Chem. Abstr.* **16**, 2778.

Cracked Petroleum Oils and Process and Apparatus for Producing Same.—L. W. Goold. From Universal Oil Products Co. Brit. Pat. 185,439.

Oil Cracking Process and Apparatus Therefor.—C. A. Jenson. Brit. Pat. 185,624.

Distilling Petroleum under High Pressure.—C. E. Stockford. Assr. to Standard Oil Co., New York. U.S. Pat. 1,425,712. *J. Soc. Chem. Ind.* **41**, 741A. *Chem. Abstr.* **16**, 3388.

Process of Producing Light Hydrocarbons.—C. R. Burke. Assr. to L. P. Burke. U.S. Pat. 1,426,149. *J. Soc. Chem. Ind.* **41**, 741A.

Process for the Production of Low Boiling Point Hydrocarbons.—J. C. Black. U.S. Pat. 1,426,813. *J. Soc. Chem. Ind.* **41**, 741A.

Process and Apparatus for Cracking Hydrocarbons.—F. G. Niece. Brit. Pat. 185,632. *Chem. Age* **7**, 568.

Distilling and Cracking Hydrocarbons.—S. L. Tartlan and A. E. Gooderham. Brit. Pat. 179,644. *Chem. Abstr.* **16**, 3388.

Cracking Hydrocarbon Oils.—C. R. Burke. U.S. Pat. 1,425,149. *Chem. Abstr.* **16**, 3388

Converting Petroleum Oils with Aluminium Chloride.—A. M. McAfee. Assr. to Gulf Refining Co. U.S. Pat. 1,424,574. *Chem. Abstr.* **16**, 3388. *J. Soc. Chem. Ind.* **41**, 702A.

Separating Aluminium Chloride from Heavy Hydrocarbons.—C. O. Hoover. U.S. Pat. 1,426,081. *Chem. Abstr.* **16**, 3388.

Hydrocarbons.—M. Melamid. Brit. Pat. 180,625. *Chem. Abstr.* **16**, 3542.

Cracking Hydrocarbons.—C. S. Davis. Brit. Pat. 180,719. *Chem. Abstr.* **16**, 3542.

Distilling and Cracking Hydrocarbon Oils.—E. O. Linton. Brit. Pat. 180,657. *Chem. Abstr.* **16**, 3542.

Treating Hydrocarbon Oils to Reduce Viscosity.—J. P. Persch. Brit. Pat. 181,034. *Chem. Abstr.* **16**, 2542.

METHOD AND APPARATUS FOR TREATING OR CONVERTING COMPOUNDS PREFERABLY OF A HYDROCARBON NATURE.—W. J. KNOX. Assr. to E. D. Warren. U.S. Pat. 1,428,641. *J. Soc. Chem. Ind.* **41**, 850A.

PROCESS FOR MAKING HYDROCARBONS AND THEIR DERIVATIVES BY HEATING COAL OR HYDROCARBONS WITH HYDROGEN.—S. LÖFFLER. Ger. Pat. 303,332. *J. Soc. Chem. Ind.* **41**, 850A.

APPARATUS FOR TREATING PETROLEUM VAPOURS WITH MOLTEN METAL.—D. W. HOGE. U.S. Pat. 1,418,375. *Chem. Abstr.* **16**, 2779.

PROCESS FOR DECOMPOSING COAL, HYDROCARBONS AND THE LIKE UNDER HIGH TEMPERATURES AND PRESSURES.—S. LÖFFLER. Ger. Pat. 306,356. *J. Soc. Chem. Ind.* **41**, 801A.

CRACKING HYDROCARBON OILS.—W. F. RITTMAN. U.S. Pat. 1,419,121. *Chem. Abstr.* **16**, 2778.

CRACKING HYDROCARBON OILS UNDER PRESSURE.—A. A. WELLS. U.S. Pat. 1,418,414. *Chem. Abstr.* **16**, 2778.

CRACKING OILS.—G. L. HOXIE. U.S. Pat. 1,418,713. *Chem. Abstr.* **16**, 2778.

CONVERTING OILS WITH ALUMINIUM CHLORIDE.—Gulf Refining Co. U.S. Pat. 1,424,574. *Oil Paint and Drug Reporter* **102**, (8), 47. *J. Ind. Eng. Chem.* **14**, 839.

APPARATUS FOR REACTIONS AT HIGH TEMPERATURES UNDER PRESSURE.—A. T. STUART and G. N. MIDDLETON. U.S. Pat. 1,417,585. *Chem. Abstr.* **16**, 2624.

INSULATING OILS.

THE DIELECTRIC STRENGTH OF OIL.—J. L. R. HAYDN and W. N. EDDY. *Eng. World* (July 7).

THE PROBLEM OF DURABILITY TESTS FOR TRANSFORMER OILS.—T. G. DELBRIDGE. *Eng. World* (June 6).

DIELECTRIC (BREAKDOWN) VALUE OF INSULATING OILS.—R. M. FRIESE. *Wiss. Veroffentl. Siemens-Konzern* **1**, 41. *Chem. Abstr.* **16**, 2043.

PATENTS.

PROCESS OF PURIFYING AND DEHYDRATING TRANSFORMER OIL.—C. H. HAPGOOD. Assr. to The De Laval Separator Co. U.S. Pat. 1,425,645. *J. Soc. Chem. Ind.* **41**, 741A.

SHALE OILS.

THE CHEMICAL COMPOSITION OF ESTHONIAN "KUKERSITE."—P. N. KOGERMAN. *Petr. Times* **8**, 389, 535. *J. Soc. Chem. Ind.* **41**, 799A.

FACTORS INFLUENCING THE VALUE OF OIL SHALE LANDS.—D. E. WINCHESTER. *Eng. Min. J. Press* (July 8). *Petr. Times* **8**, 413.

Oil Shale.—H. I. Jenson. *Queensland Govt. Min. J.* (Mar.) 92, (Oct.) 401 (1921). *Bull. Imp. Inst.* **19**, 548. *Chem. Abstr.* **16**, 2777.

Oil Shales and Petroleum Prospects in Brazil.—H. E. Williams. *Trans. Amer. Inst. Met. Eng.* **65**, 69. *Chem. Abstr.* **16**, 2777.

Shale in Spain.—J. Gavala. *Bol. Inst. Geol. Espana* **4**, 265. *Bull. Imp. Inst.* **19**, 549. *Chem. Abstr.* **16**, 2830.

Shale Distillation in Australia.—*Trans-Pacific* (July). *Oil Engineering and Finance* **2**, 363.

The Oil Area of Newfoundland.—R. Squires. *Oil Engineering and Finance* **2**, 366.

The Oil Shales of New Albany.—A. H. Hallam. *Oil Engineering and Finance* **2**, 384.

Oil Shale from a Mining Viewpoint.—C. C. Starr. *Railroad Red Book* (June).

Significance of England's Oil Shales.—H. E. Ackroyd. *Petr. Times* **7**, 576. *Chem. Abstr.* **16**, 3197.

The Newer Methods of Shale Oil Extraction.—A. E. von Grooling. *Petroleum* **18**, 487, 539. *Chem. Abstr.* **16**, 3198.

Internally Heated Retorts.—N. H. Freeman. *Petr. Times* **8**, 86. *Chem. Abstr.* **16**, 3198.

The Oil Shale Position in South Africa.—*Petr. Times* **8**, 580.

Shale-oil Developments of the Last Two Years.—R. H. McKee. *J. Ind. Eng. Chem.* **14**, 847. *Petr. Times* **8**, 581. *Chem. Abstr.* **16**, 3386.

Oil Shale Deposits of Pictou County, Nova Scotia.—*U.S. Commerce Repts., Aug.*, p. 530.

A Summary of the French Deposits of Oil Shale. Brunschweig. International Oil Congress, Paris. *Oil Engineering and Finance* **2**, 477.

The Development of Oil-shales and Torbanites.—E. H. Cunningham-Craig and P. W. Dumas. International Oil Congress, Paris. *Oil Engineering and Finance* **2**, 478.

The Composition of Peat and Shale Tar.—J. Marcusson and M. Picard. *Petroleum* **18**, 637. *Chem. Abstr.* **17**, 3370.

The New Albany Shale of Indiana.—J. R. Reeve. *U.S. Bur. Mines Repts. Investigations* 2390.

Large Part of Kentucky underlaid with Oil Shales.—C. A. Crouse. *Chem. Age* (N.Y.), (Aug.).

Oil Shale: an Historical Technical and Economic Study.—M. J. Gavin. *U.S. Bur. Mines Bull.* 210. *Oil News* **12**, 1226.

Oil Shale of Kentucky.—V. C. Alderson. *Colorado School Mines Quar.* **17** (4). *Oil News* **12**, 1271. *Petr. Times* **8**, 751.

Oil Shale in Russia.—V. C. Alderson. *Colorado School Mines Quar.* **17** (4). *Oil News* **12**, 1271.

RETORTING OF OIL SHALES.—*Petr. Times* **8**, 233. *Chem. Abstr.* **16**, 3541.

SULPHONATED DERIVATIVES OF THE NATURALLY OCCURRING SULPHURISED HYDROCARBONS.—C. Pépin and G. Reaubourg. *J. Pharm. Chim.* **24**, 258.

RETORTING OIL SHALE ON A NEW PRINCIPLE.—*S. Afr. Min. and Eng. J. Petr. Times* **8**, 746.

PATENTS.

PROCESS OF DISTILLING SHALE.—E. E. Hedges. U.S. Pat. 1,423,716. *J. Soc. Chem. Ind.* **41**, 702A. *Chem. Abstr.* **16**, 3203.

TREATMENT OF OIL SHALE.—H. Plauson. Can. Pat. 220,517. *Chem. Abstr.* **16**, 2986.

VERTICAL RETORTS FOR TREATING OIL-BEARING SHALE.—G. A. Heimbucher. U.S. Pat. 1,421,228.

DISTILLING.—G. A. Bronder and T. Costigan. Brit. Pat. 176,847. *Chem. Abstr.* **16**, 3148.

RETORT FURNACE AND CONDENSING APPARATUS FOR THE EDUCTION OF OIL AND FUEL GAS FROM OIL SHALES AND SANDS.—C. L. Buckingham. U.S. Pat. 1,425,074. *J. Soc. Chem. Ind.* **41**, 741A. *Chem. Abstr.* **16**, 3388.

RETORTS OR FURNACES FOR DISTILLING SHALE, ETC.—J. P. W. Webster. Brit. Pat. 184,040. *J. Soc. Chem. Ind.* **41**, 742A.

MANUFACTURE OF ICHTHYOL, ICHTHYOL PREPARATIONS AND THE LIKE.—Plauson's (Parent Co.), Ltd. From H. Plauson. Brit. Pat. 184,292. *J. Soc. Chem. Ind.* **41**, 786A.

APPARATUS FOR CARBONISATION OF COAL, SHALE, PEAT AND THE LIKE.—H. P. Hird. Brit. Pat. 184,525. *J. Soc. Chem. Ind.* **41**, 802A.

DISTILLATION OF MATERIAL CARRYING A PERCENTAGE OF VOLATILE MATTER (*e.g.*, SHALE, ETC.).—G. McJohns, Assr. to The Industrial Process Engineering Co. U.S. Pat. 1,423,527. *Chem. Abstr.* **16**, 3202.

PROCESS AND APPARATUS FOR RECOVERY OF HYDROCARBONS FROM OIL SHALE.—C. W. Thompson. U.S. Pat. 1,428,458. *J. Soc. Chem. Ind.* **41**, 850A.

18. LIGNITES AND COALS AND THEIR PRODUCTS.

PLASTIC FUEL CAN BE MADE OF LOW-GRADE COAL AND OIL, AND CAN BE COKED EVEN IF NON-COKING COAL IS USED.—G. H. Dacy. *Coal Age* **21**, 953. *Chem. Abstr.* **16**, 2768.

NEW METHODS OF INVESTIGATING LIGNITE.—R. Potonié. *Braunkohle* **21**, 33. *Chem. Abstr.* **16**, 2769.

LIGNITE DRYING AND DUST FUEL.—Weiss. *Braunkohle* **21**, 79. *Chem. Abstr.* **16**, 2769.

THE GASIFICATION OF CRUDE RHENISH LIGNITE AND ITS COURSE OF ACTION WHEN PRE-DRIED LIGNITE IS USED.—G. Müller. *Braunkohle* **21**, 1, 49. *Chem. Abstr.* **16**, 2773.

REPORT OF THE FUEL RESEARCH BOARD FOR THE YEARS 1920, 1921—SECOND SECTION: LOW TEMPERATURE CARBONISATION. H.M. Stationery Office, London.

THE PRODUCTION AND USE OF MONTAN WAX.—Kausch. *Z. deut. Oel.-Fett. Ind.* **42**, 361. *Chem. Abstr.* **16**, 2977.

THE ACTION OF NITRIC ACID ON LIGNITE AND HUMIC ACID.—A. Schellenberg. *Brennstoff Chem.* **2**, 384. *Chem. Abstr.* **16**, 2978.

A NEW ADVANCE IN THE GASIFICATION OF LIGNITE.—E. Roth. *Braunkohle* **21**, 154. *Chem. Abstr.* **16**, 2979.

DISTILLATION AND GASIFICATION OF LIGNITE.—K. Arnemann, et al. *Braunkohle* **21**, 124. *Chem. Abstr.* **16**, 2979.

HIGH VACUUM DISTILLATION PLANT FOR LIGNITE TAR.—R. Neumann. *Petroleum* **17**, 1257. *Chem. Abstr.* **16**, 2981.

NOTES ON THE COMMUNICATION OF S. RUHMANN ON "LIGNITE PRODUCER TAR."—F. Fischer. *Ber.* **55B**, 505. *Chem. Abstr.* **16**, 2982.

DEVONSHIRE LIGNITES.—*Oil Engineering and Finance* **2**, 369.

LOW-TEMPERATURE CARBONISATION.—J. H. Frydlender. *Rev. prod. chim.* **25**, 185, 217, 361, 397.

THE NATURE OF THE FATTY ACIDS OBTAINED BY OXIDATION OF LIGNITE TAR OIL.—E. Wentzel. *Seife* **44** (1). *Chim. et Industrie* **7**, 1176. *Chem. Abstr.* **16**, 3194.

ASPHALTIC SUBSTANCES IN LIGNITE PRODUCER TAR.—J. Mzourek. *Petroleum* **18**, 77. *Chem. Abstr.* **16**, 3201.

HOME FUEL FROM COAL BY LOW-TEMPERATURE COMBUSTION.—Counerade. International Oil Congress, Paris. *Oil Engineering and Finance* **2**, 476.

THE LIGNITE DEPOSITS OF FRANCE.—Brunschweig. International Oil Congress, Paris. *Oil Engineering and Finance* **2**, 483.

MODERN RETORTS FOR THE LOW-TEMPERATURE CARBONISATION OF LIGNITE.—C. Berthelot. International Oil Congress, Paris. *Oil Engineering and Finance* **2**, 483.

THE DISTILLATION OF LIGNITE AND RECOVERY OF BY-PRODUCTS.—Mariller. International Oil Congress, Paris. *Oil Engineering and Finance* **2**, 484.

MONTAN WAX AND CREAM POLISHES.—P. Huc. *Industries du cuir* **1922**, 217. *Chem. Abstr.* **16**, 3366.

THE LIGNITE PROBLEM.—A. Moschetti. *Rass. Min.* **56**, 6. *Chem. Abstr.* **16**, 3378.

MODERN METHODS OF TREATING LIGNITES.—C. Berthelot. *Chim. et Ind.* **7**, 1079. *Chem. Abstr.* **16**, 3378.

LIGNITES AND BITUMINOUS SHALES. A. Guiselin. *Chim. et Ind.* **7**, 1225. *Chem. Abstr.* **16**, 3378.

HIGH VACUUM DISTILLATION IN THE LIGNITE TAR INDUSTRY.—E. Grüla. *Brennstoff Chem.* **3**, 167. *Chem. Abstr.* **16**, 3383.

COMPOSITION OF LOW-TEMPERATURE COAL-TAR AND PITCH THEREFROM.—J. Marcusson and M. Picard. *Z. angew. Chem.* **35**, 493.

THE ACIDS OF MONTAN WAX.—H. Tropsch and A. Kreutzer. *Brennstoff Chem.* **3**, 177, 193, 212. *Chem. Abstr.* **16**, 3464.

LOW-TEMPERATURE TAR RECOVERY IN BOILER-FIRING AND THE SIGNIFICANCE OF SUCH TAR TO GERMAN INDUSTRY.—C. Gerdes. *Brennstoff Chem.* **3**, 113, 129, 147, 199, 215. *Chem. Abstr.* **16**, 3539.

PHENOLS OF LOW-TEMPERATURE TARS.—A. Weindel. *Brennstoff Chem.* **3**, 245. *J. Soc. Chem. Ind.* **41**, 852A.

DISTILLATION OF LIGNITE.—*Petr. Times* **8**, 761.

PATENTS.

PROCESS OF AND APPARATUS FOR LOW-TEMPERATURE CARBONISATION OF MATERIALS.—G. Polysius. Brit. Pat. 157,318 and 178,126. *J. Soc. Chem. Ind.* **41**, 702A.

MONTAN WAX FROM COAL.—H. Plauson. Can. Pat. 220,516. *Chem. Abstr.* **16**, 2982.

LOW-TEMPERATURE DISTILLATION OF COAL.—J. Swinburne. Can. Pat. 220,705. *Chem. Abstr.* **16**, 2982.

FURNACE FOR DISTILLING COAL AT LOW TEMPERATURE.—S. Murayama and The Mitsui Kozan Kabushi Kaishi (The Mitsui Mining Co.). Jap. Pat. 39,546.

LUBRICANTS.—E. Eichwald and P. Hardt. Brit. Pat. 178,113. *Chem. Abstr.* **16**, 3148.

LOW-TEMPERATURE CONTINUOUS DISTILLATION OF FUEL.—A. C. Michie and E. G. Weeks. U.S. Pat. 1,423,134. *Chem. Abstr.* **16**, 3196.

SYSTEM OF LOW-TEMPERATURE CARBONISATION.—J. A. Yeadon. Brit. Pat. 185,684. *J. Soc. Chem. Ind.* **41**, 851A.

DRYING OF LIGNITE.—K. W. J. H. Jacobs. Brit. Pat. 163,719. *J. Soc. Chem. Ind.* **41**, 739A.

19. PITCH, ASPHALT AND BITUMEN.

ASPHALT AND RELATED BITUMENS IN 1921.—K. W. Cottrell. Separate from *Mineral Resources of the United States*, 1921, *Part* 2.

TAR SAND EXPERIMENTS IN THE ATHABASKA FIELD.—G. A. Ings. *Oil and Gas J.* **21**, 92. *Chem. Abstr.* **16**, 3200.

ASPHALT DEPOSITS OF LATTAKIA.—E. Marckwald. *Petroleum* **18**, 165. *Chem. Abstr.* **16**, 3201.

PETROLEUM ASPHALTS IN THE ROOFING AND WATER-PROOFING INDUSTRIES.—D. Finley. *Chem. and Met. Eng.* **27**, 798.

Patents.

Carbon Black from Bituminous Sands.—A. S. Cooper. U.S. Pat. 1,423,193. *Chem. Abstr.* **16**, 3177. *J. Soc. Chem. Ind.* **41**, 720A.

Carbonisation of Pitch and the like.—K. Kubierschky. Ger. Pat. 354,213. *J. Soc. Chem. Ind.* **41**, 802A.

Manufacture of Bituminous Compositions Suitable for Building or for Forming Road or like Surfaces.—A. R. Tabary. Brit. Pat. 183,914. *J. Soc. Chem. Ind.* **41**, 816A.

Bituminous Compositions.—F. Lamplough and Townmead Construction Co. Brit. Pat. 178,558. *Chem. Abstr.* **16**, 3542.

Retorts for Distillation (of Bituminous Materials).—Deutsche Petroleum A.-G. S. Kaeser and E. Bauer. Brit. Pat. 165,724. *J. Soc. Chem. Ind.* **41**, 852A.

20. Paraffin, Ozokerite and Vaseline.

The Solid Paraffins in Petroleum.—M. A. Rakusin. *Petroleum* **18**, 5, 42. *Chem. Abstr.* **16**, 3199.

Composition of Paraffin Wax.—F. Francis, C. M. Watkins and R. W. Wallington. *J. Chem. Soc.* **121**, 1529. *J. Soc. Chem. Ind.* **41**, 800A. *Chem. Abstr.* **16**, 3463.

21. Origin of Petroleum.

Have Scientists Found the Correct Theory of Petroleum Origin?—*Petr. World* (Los Angeles), (July).

Theories of the Inorganic Origin of Petroleum.—*Petr. Times* **8**, 441.

The Probable Mother-substance of Petroleum.—R. Thiessen. Am. Chem. Soc. *Petr. Times* **8**, 462.

The Origin of Petroleum.—R. E. Somers. Am. Chem. Soc. *Petr. Times* **8**, 462.

The Formation of Petroleum.—H. Höfer. Allege. öst. Chem. Tech. Z. *Oil Engineering and Finance* **2**, 443. *Oil News* **12**, 1151.

Origin of Petroleum (Nitrogen Compounds of Petroleum and particularly of Baku Petroleum).—E. Pyhälä. *Petroleum* **17**, 1069. *Oil Engineering and Finance* **2**, 447. *J. Soc. Chem. Ind.* **41**, 799A.

22. Physical Properties of Petroleum and its Products.

Refractometric Examination of Petroleum and Petroleum Products.—Utz. *Petroleum* **17**, 1293. *Chem. Abstr.* **16**, 2775.

The Vapour Pressure of Solutions of Benzol, Hexane and Cyclo-Hexane in Lubricating, Gas Absorbent and Vegetable Oils, with Molecular Weight Data.—R. E. Wilson and E. P. Wylde. Am. Chem. Soc. *Petr. Times* **8**, 423. *Petr. World* **19**, 427.

EFFECT OF CERTAIN PHYSICAL AND CHEMICAL PROPERTIES OF EMULSIFYING AGENTS ON THE STABILITY OF OIL-WATER EMULSIONS.—L. W. Parsons and B. Mead. Am. Chem. Soc. *Petr. Times* **8**, 423. *Petr. World* **19**, 428.

VISCOSITY TEMPERATURE CURVES OF FRACTIONS OF TYPICAL AMERICAN CRUDE OILS (SECOND PAPER).—F. W. Lane and E. W. Dean. Am. Chem. Soc. *Petr. Times* **8**, 461. *Petr. World* **19**, 429.

APPLICATIONS OF VAPOUR PRESSURE MEASUREMENTS.—H. S. Davis. Am. Chem. Soc. *Petr. World* **19**, 427.

METHOD OF CORRECTING VOLUME OF OIL FOR TEMPERATURE VARIATIONS.—T. G. Delbridge. *Nat. Petr. News* **14**, 41. *Chem. Abstr.* **16**, 3198.

TEMPERATURE-PRESSURE CURVES OF PETROLEUM PRODUCTS.—M. B. Cooke. *U.S. Bur. Mines Rept. Investigations* 2368. *Petr. World* **19**, 313. *Chem. Abstr.* **16**, 3198. *Chem. and Met. Eng.* **27**, 504. *J. Soc. Chem. Ind.* **41**, 800A.

CHEMISTRY OF PETROLEUM.

CALCULATION OF FLASH POINTS.—E. Mack, C. E. Boord and H. N. Barham. Am. Chem. Soc. *Petr. World* **19**, 427.

CATALYTIC OXIDATION OF SATURATED PARAFFIN HYDROCARBONS AND FATTY ACIDS.—A. H. Salway and P. N. Williams. *J. Chem. Soc.* **121**, 1343. *J. Soc. Chem. Ind.* **41**, 719A. *Chem. Abstr.* **16**, 3064.

ISOPROPYL ALCOHOL.—D. H. Grant and C. O. Johns. *Am. J. Pharm.* **94**, 418. *Chem. Abstr.* **16**, 2944.

THE OCCURRENCE OF WAX IN PETROLEUM OILS.—J. E. Hackford. *Oil Engineering and Finance* **2**, 381.

THE INFLUENCE OF THE ELEMENTS OF THE OXYGEN GROUP ON PARAFFIN.—H. Siebeneck. *Petroleum* **18**, 281. *Chem. Abstr.* **16**, 3200. *Oil Engineering and Finance* **2**, 503.

THE PROBABILITY OF REACTION BETWEEN SULPHUR AND SOLID PARAFFIN IN THE MINERAL OIL-BEARING REGIONS.—M. A. Rakusin. *Petroleum* **18**, 581. *Chem. Abstr.* **16**, 3200.

THE OXIDATION OF AROMATIC AND ALIPHATIC HYDROCARBONS.—*Chem. Age* **7**, 410.

THE OZONIDES OF PETROLEUM.—R. Koetschau. *Z. angew. Chem.* **35**, 509. *Oil Engineering and Finance* **2**, 447. *J. Soc. Chem. Ind.* **41**, 848A.

THE ACTION OF OZONE ON HYDROCARBONS WITH SPECIAL REFERENCE TO THE PRODUCTION OF FORMALDEHYDE.—T. S. Wheeler and E. W. Blair. *J. Soc. Chem. Ind.* **41**, 331T.

BURNING POINTS OF LIGHT LIQUID FUELS.—W. R. Ormandy and E. C. Craven. International Oil Congress, Paris. *Oil Engineering and Finance* **2**, 475.

THE INTERNAL LINKAGES OF HYDROCARBONS AND THEIR ENERGY VALUES.—J. P. Wibaut. International Oil Congress, Paris. *Oil Engineering and Finance* **2**, 476.

THE IDENTIFICATION OF ALIPHATIC HYDROCARBONS IN FRACTIONS OF PETROLEUM.—H. Gault. International Oil Congress, Paris. *Oil Engineering and Finance* **2**, 476.

THE CATALYTIC TRANSFORMATION OF VEGETABLE AND ANIMAL OILS INTO PETROLEUM.—A. Mailhe. *Ann. chim.* **17**, 304. *Chem. Abstr.* **16**, 3304.

SOME NEW PETROLEUM PRODUCTS.—J. H. James. *Chem. Met. Eng.* **26**, 209. *Chem. Abstr.* **16**, 3386.

GUM-FORMING CONSTITUENTS IN GASOLINE.—N. A. C. Smith and M. B. Cooke. *U.S. Bur. Mines Rept.* 2394. *Oil Engineering and Finance* **2**, 555. *Petr. World* **19**, 451.

FOURTH REPORT ON COLLOID CHEMISTRY AND ITS GENERAL AND INDUSTRIAL APPLICATIONS.—H.M. Stationery Office, London.

THE CHEMISTRY OF PETROLEUM.—J. D. Gill. Atlantic Lubricator. *Petr. Age* **10**, (8), 80; (9), 86.

PATENTS.

OXIDISING OLEFINES.—C. Ellis. U.S. Pat. 1,418,368. *Chem. Abstr.* **16**, 2695.

MANUFACTURE OF SYNTHETIC WAXES.—G. Schicht, A.-G. and A. Grün. Brit. Pat. 183,186. *J. Soc. Chem. Ind.* **41**, 719A.

CHLORINATED METHANE.—W. O. Snelling. U.S. Pat. 1,421,733. *Chem. Abstr.* **16**, 2867.

PHOTOCHEMICAL REACTIONS (HALOGENATING HYDROCARBONS).—W. O. Snelling. U.S. Pat. 1,420,346. *Chem. Abstr.* **16**, 2867.

CHLORINATING GASEOUS HYDROCARBONS.—G. O. Curme, Jr. U.S. Pat. 1,422,838. *Chem. Abstr.* **16**, 3093.

PROCESS OF TREATING HYDROCARBON OILS. MINERAL-OIL DERIVATIVES.—H. T. Maitland, Assr. to Sun Co. U.S. Pat. 1,425,882–5. *J. Soc. Chem. Ind.* **41**, 741A. *Chem. Abstr.* **16**, 3388.

CHLORINATION OF METHANE.—Holzverkohlungs Industrie Akt.-Ges. and K. Roka. Brit. Pat. 186,270. *Chem. Age* **7**, 612.

FATTY ACIDS, ALDEHYDES AND KETONES FROM MINERAL AND TAR OILS.—C. Harries. Ger. Pat. 339,562. *Chem. Abstr.* **16**, 3486.

OIL GAS AND PETROL GAS.

PATENT.

GAS FROM HEAVY OIL.—O. B. Evans and H. G. Terziam. U.S. Pat. 1,418,782. *Chem. Abstr.* **16**, 2775.

MISCELLANEOUS.

THE COST OF ACCOUNTING IN THE OIL INDUSTRY.—National Assoc. of Cost Accountants, New York.

INTERNATIONAL ASPECTS OF THE PETROLEUM INDUSTRY.—V. H. Manning. *Trans. Am. Inst. Min. Met. Eng.* **65**, 78. *Chem. Abstr.* **16**, 2775.

American Fuels.—R. F. Bacon and W. A. Hamor. McGraw-Hill Book Co., New York, and London.

Saving the Oil Industry from Costly Errors.—Magazine of Wall Street. *Petr. Times* **8**, 465.

Carbon Ratios of Coals in West Virginia Oil Fields.—D. B. Reger. *Trans. Am. Inst. Min. Met. Eng.* **65**, 522. *Chem. Abstr.* **16**, 2828.

Genetic Problems Affecting Search for New Oil Regions.—D. White. *Trans. Am. Inst. Min. Met. Eng.* **65**, 176. *Chem. Abstr.* **16**, 2828.

Petroleum Education.—E. De Barr and F. W. Padgett. *Chem. Met. Eng.* **27**, 125.

Artificial Petroleum from Fish Oils.—H. K. Kobayashi and E. Yamaguchi. *J. Chem. Ind.* (*Japan*) **24**, 1399. *Chem. Abstr.* **16**, 2983.

Artificial Petroleum from Soya Bean, Coconut and Chrysalis Oils and Stearin.—K. Kobayashi. *J. Chem. Ind.* (*Japan*) **24**, 1421. *Chem. Abstr.* **16**, 2983.

Preparation of a Liquid Resembling Petroleum by the Distillation of the Calcium Salts of Soy-Bean-Oil Fatty Acids.—M. Sâto. *J. Chem. Ind.* (*Japan*) **25**, 13. *Chem. Abstr.* **16**, 2984.

A Handbook of Petroleum, Asphalt and Natural Gas.—R. Cross. *Kansas City Testing Laboratory Bull.* 16.

Petroleum and Where to Find It.—A. Blum. Modern Mining Books Publishing Co., Chicago.

The Petroleum and Allied Industries.—J. Kewley. Balliere, Tindall & Cox.

A Short Excursion through the Realm of Petroleum (Utilisation).—W. Schneider. *Brennstoff Chem.* **3**, 171. *Chem. Abstr.* **16**, 3386.

Conversion Tables for the Oil and Chemical Trades.—L. N. Rawes. Major and Co., Ltd., Hull.

American Petroleum Institute and Petroleum Research.—*Oil Engineering and Finance* **2**, 526.

The Possibilities of Synthetic Petroleum.—*Petr. Times* **8**, 636.

The Oil Supply of the World.—D. White. *Mech. Engineering.*

The Chemistry and Technology of Petroleum.—F. Esling. *Oil News* **12**, 1104, 1143, 1167, 1209, 1227, 1269, 1287.

Patent.

Process of Manufacturing Liquid Hydrocarbons from Fish Oils.—K. Kobayashi. Brit. Pat. 170,264. *J. Soc. Chem. Ind.* **41**, 701A.

ERRATA.

Page 506, line 3 from bottom, *for* "Abri" *read* "Abu."
Page 506, line 2 from bottom, *for* "M. Sadek" *read* "H. Sadek."

Abstracts.

Compiled by Paul Dvorkowitz, Ph.D., H. Moore, M.Sc., F. G. P. Remfry, B.A., D.Sc., A.I.C., and T. A. Smith, B.Sc., F.I.C.

General.

The Composition of Paraffin Wax. Part II.—F. Francis, C. M. Watkins, and R. W. Wallington. *J. Chem. Soc.*, 1922, 1529-35.

An investigation into the results of oxidation of paraffin wax, published in the *J.C.S.* earlier in the year (p. 512), gave indications that a separation into its constituents was possible. The present paper deals with the results of repeated fractionation under very low pressures. Wax of Scotch origin, melting at 55–6° C, was distilled under a pressure of 0.12 to 0.05 mm., and after 21 fractionations the limits of separation were reached, and 22 fractions boiling within 5° ranges, from 150° C. to 260° C., were obtained. The three largest fractions were 13.7%, b.p. 160–5° C., 17.2%, b.p. 180–5° C. and 15.7%. b.p. 190–5° C under 0.1 mm. pressure. On refractionation of the larger fractions constant boiling substances were obtained, and it is considered that about 80% of the wax was composed of seven distinct substances, of which the melting points and molecular weights increase regularly with rise in boiling point, ranging from 37.8°–66.6° C. and 291–434 respectively. The physical properties of these substances, however, such as density and refractive index, did not correspond with any of the known synthetic hydrocarbons of similar molecular weight, and the conclusion arrived at is that normal hydrocarbons of the paraffin series do not exist in the wax on which the experiments were carried out. F. G. P. R.

The Change in Viscosity of Oils with Temperature.—W. H. Herschel. *J. Ind. Eng. Chem.*, 1922, **14**, 715–723.

A highly specialised paper dealing with the theoretical and mathematical side of the problem. The original should be consulted for figures and details. There is no satisfactory theoretical equation for the change of viscosity with temperatures. The four-constant equation of Bingham is most suitable for definite chemical compounds of low viscosity and the three constant equations of Slotte for oils of comparatively high viscosity. Oelschlager's assumption that logarithmic viscosity-temperature graphs are straight lines is sufficiently accurate for practical purposes if only oils of medium viscosity are considered, excluding spindle oils, aeroplane motor oils and fatty, compounded and unrefined oils. Provided the oils are thus limited and are of the same base the viscosity-temperature graphs meet approximately at a point. The equation for change of viscosity with temperature may be used to calculate the temperature of average viscosity, but it is accurate enough to take this temperature as equal to the highest minus one-third the range of temperature. F. G. P. R.

SULPHUR COMPOUNDS AND OXIDATION OF PETROLEUM OILS.—C. E. Waters. *J. Ind. Eng. Chem.*, 1922, **14**, No. 8, 725–7.

The author found that free sulphur, when added to heavy oils at the rate of 0.1%, did not appreciably affect the amount of asphaltic matter formed by heating in air. This result was contrary to former experience, and further observation indicated that the amount of sulphur added was insufficient to affect the rate of oxidation. Thirty-seven oils were heated to 250° C. in contact with air for 2.5 hours, diluted with petroleum ether and the precipitate weighed. In several it was found that this "carbonization value"—*i.e.*, the precipitate calculated as percentage of the original oil, varies directly with the amount of sulphur compounds in the oil. The same result was found by exposing the oils to sunlight and air for 100 hours, and in each case the precipitates were found to contain a much larger percentage of sulphur than the original oil, whilst the filtered oil contained less. Transformer and turbine oil sludges, as well as the "carbon" deposit from cylinders of internal combustion motors, were found to contain relatively large amounts of sulphur. By heating oils in a crucible covered with a watch glass and resting inside a larger crucible it was found that sulphur compounds accumulated in the undistilled residue up to a certain point, but that when complete dryness was approaching a rapid elimination of sulphur took place. Thus, in cracking and distillation the sulphur compounds are not driven off as fast as the majority of the oil and tend to accumulate in the residual deposits. F. G. P. R.

DETERMINATION OF ABSOLUTE VISCOSITY OF PETROLEUM OILS.—W. H. Fulweiler and C. W. Jordan. *J. Ind. Eng. Chem.*, 1922, **14**, No. 8, 723.

Using the Bingham and Green type of viscometer the authors have found that when the material under examination is allowed to stand in glass viscometers for periods up to 24 hours and over a change in viscosity of the order of 0.5% takes place, the order of precision of the observation being 0.1%. No difference in the magnitude or sign of the change was noticed between periods of 24 hours and three weeks standing in the viscometers. Apparently samples of animal, vegetable or petroleum oils intended for use as viscosity standards, should be checked from time to time until more is known regarding the nature and extent of this change on standing. F. G. P. R.

TEMPERATURE-PRESSURE CURVES OF PETROLEUM PRODUCTS.—M. B. Cooke, *Chem. Met. Eng.*, 1922, **27**, No. 10, 504.

In the course of work on the gum-forming constituents of gasoline the pressures developed by various petroleum products at increasing temperatures had occasion to be measured. The apparatus consisted of a steel bomb of 160cc. capacity, fitted with a pressure gauge, which was heated in an oil bath by means of which the temperature was observed. One sample of casing head gasoline, two of commercial motor gasoline, one of kerosene and one of transformer oil were tested. 200 lbs. pressure was obtained at temperatures of 140° C., 205° C., and 235° C. respectively by the gasolines; 50 lbs. was reached by the kerosene at 255° C. and 40 lbs. at 240° C. by the transformer oil. In general the pressure generated at elevated temperatures varies inversely with the average boiling point of the product. The temperature-pressure curves, however, are not parallel, due to the varying composition of the products. Low boiling petroleum products, such as casing head gasoline, generate a higher pressure than water vapour at a given temperature.

F. G. P. R.

CHEMICAL CONTROL OF GASEOUS DETONATION WITH PARTICULAR REFERENCE TO THE INTERNAL COMBUSTION ENGINE.—T. Midgley, Jr., and T. A. Boyd. *J. Ind. Eng. Chem.*, 1922, **14**, No. 10, 894–8.

The authors review previous work on gaseous detonation, most of which, however, having been done at atmospheric pressure, does not simulate the conditions found in an internal combustion engine. Detonation, or "pinking," is influenced by many causes which include the chemical constitution of the fuel, the compression ratio of the engine, the design of the combustion chamber, etc. Three theories have been put forward to explain this phenomenon :—(1) That it is a mechanical impact between parts of the mechanism ; (2) that the part of the charge which is first ignited compresses the remainder so rapidly that the heat produced brings about spontaneous ignition, which is nearly simultaneous throughout the mass ; and (3) that it is due to impact against the cylinder head of a high-velocity high-pressure wave which precedes the actual flame of combustion. The last theory was put forward to explain the behaviour of the minute quantities of certain materials in preventing detonation which appear to have a negative catalytic effect on the reaction velocity of combustion. These substances are known as "anti-knock materials," the most powerful of which are certain organic compounds of tin, selenium, tellurium, and lead—their efficiency increasing in the order given. Bromine and oxygen accelerate the velocity of combustion, whilst iodine and nitrogen retard it, but benzol acts merely as a diluent which can itself withstand very high compression without detonating. As a comparison of efficiency one molecule of diethyl selenide and one of benzol will prevent knocking in 11,750 and 150 molecules respectively of fuel-air mixture, whilst one molecule of lead tetraethyl will suffice for as much as 215,000 of fuel mixture. It is inconceivable that this effect can be due to an energy factor owing to the minute quantities of active substance present, and the theory of catalytic retardation of the chemical reaction, combustion, seems the only possible one. The preventive effect does not increase indefinitely in proportion to the amount of "anti-knock" material present, but tends towards a maximum. By retarding the velocity of combustion it tends to insure its completeness and thus increases the efficiency of the fuel, but unlike ordinary catalysts these negative ones are themselves destroyed in the reaction, being for the most part combustible materials. In practical use the merest whiff of vapour from a bottle containing any of these compounds when drawn into the engine with the charge of fuel, is sufficient to prevent knocking with even the most virulent types.

F. G. P. R.

ADSORPTION AND CATALYSIS IN FULLERS EARTH.—E. K. Rideal and W. Thomas. *J. Chem. Soc.*, 1922, **122**, 2119–2123.

In bleaching edible oils the efficiency of various types of fullers earths varies with the nature of the oil, and it is possible that a part of the colour removal is due to catalytic activity of the earths as oxidising agents, the source of oxygen being adsorbed air in the fresh material. Florida, Surrey and Somerset earths were tried, and it was found that the adsorption of methylene blue from aqueous solution was approximately proportional to the specific surfaces of the earths (neglecting porosity, if any), but that their catalytic activity in decomposing hydrogen peroxide was not in the same order as the adsorptive powers and was evidently in no way related to either the latter or to the specific surface of the earths. It was considered that the iron content may be the governing factor in the catalysis.

F. G. P. R.

ACETONE AS A SOLVENT FOR MINERAL OILS.—*Chem. Met. Eng.*, 1922, **27**, No. 15, 751.

The Mellon Institute find that acetone does not possess high solvent properties for mineral lubricating oils. The solvent power decreases as the viscosity of the oil increases. With petrol and kerosene acetone is miscible in all proportions, but has very little action at all on paraffin wax. For these reasons it has been used in the removal of paraffin wax from shale and lignite oils and also for ridding lubricating oils of tarry matter.

F. G. P. R.

THE IODINE FIGURE OF MINERAL OILS BY HANUS' METHOD.—*J. Hladky Chem. Listy*, 1922, **16**, 207–211.

Hanus' solution of iodine bromide in carbon tetrachloride was found to depreciate less rapidly than those of Hubl and Wijs (E. Graefe, *Petroleum*, 1905, 12, 631), and the increase in iodine value obtained by increasing the time of reaction was also smaller than with the latter solutions. A large excess of reagent must remain at the end of the reaction, but the concentration of the reagent, temperature of reaction and presence of moisture are of little importance. The accuracy obtainable is of the order of 1 to 2 units with oils of low iodine values.

F. G. P. R.

REACTIVE ACID LIQUOR, ALCOHOLS AND ESTERS FROM GASEOUS HYDROCARBONS; PROCESS FOR PRODUCTION.—S. B. Hunt. *E. P.* 173, 538, June 30, 1920.

Olefines containing more than 2 carbon atoms are removed from coke oven gases or gases from cracking plants by treating them with sulphuric of sp. gr. 1.57 to 1.8. Acid of sp. gr. higher than 1.8 is unsuitable as it produces polymerisation and below 1.57 is unsatisfactory. The stronger acid acts best at 30° C., whilst acid of 1.6 to 1.7 sp. gr. acts best at 40° C. More effective absorption of the olefines is brought about by having present a neutral liquid such as a hydrocarbon oil, insoluble in the acid, in which the olefines are dissolved before sulphonation. Sufficient agitation is produced when the gases are bubbled through the oil and acid mixture. By repeated use of the acid to extract fresh gas, acid liquor of sp. gr. 1.5 to 1.2 may be produced, according to the quantity of olefines absorbed. Alcohols are produced from the acid liquor by hydrolising and distilling. The alcohols produced are principally secondary alcohols. Esters may be obtained by adding acetic acid or salts of organic acids to the reactive acid liquors and distilling the mixture. Gas, from which the olefines containing more than 2 carbon atoms have been removed, may be treated for the removal of ethylene with 100% sulphuric acid at higher temperatures. The reaction is facilitated by having present paraffin wax of m.p. 60–70° C.

T. A. S.

PETROLEUM ASPHALTS IN ROOFING AND WATERPROOFING INDUSTRIES.—D. Finley. *Chem. Met. Eng.*, 1922, **27**, 798–802.

Prior to 1885 coal tar was mainly used in the preparation of roofing materials. Early products failed owing to the inability of manufacturers to produce standard materials capable of resisting weather and climatic conditions and of artistic appearance. The pioneers of the industry, Pearce and Beardsley, used asphalt which offered considerable resistance to chewing but would not crumble in the mouth. Modern tests are the melting and penetration tests, suitable material having a penetration of

15 at 77° F. and a melting-point of 150° F. Hard asphalts with a penetration of 2 are used in paint making and in the manufacture of glazed papers for building purposes. During the last 30 years the American consumption of asphalt in the roofing and waterproofing industries has grown from a few hundred tons to well over a quarter of a million tons per annum. T. A. S.

THE OZONIDES OF PETROLEUM.—R. Koetschau, *Z. angew. Chemie*, 1922, **35**, 509–513.

Experiments were made on the action of ozone on certain American petroleum oils. A Texas transformer oil of sp. gr. 0.915 was found to have a molecular weight of 293, while the light yellow ozonide, of which 25% was produced from this oil, had a molecular weight of 663. The solution of this ozonide in benzene, after standing a few hours, had a molecular weight of 606 only, and after two days, a molecular weight of 479, showing that polymerisation had not taken place, but decomposition into compounds of lower molecular weight. The figure 663 corresponds closely to that of a dimeric diozonide, which was 688. The molecular weight and the elementary analysis of the transformer oil and of its ozonide were ascertained. Many American crude oils and lubricating oils contain hydrocarbons very rich in carbon, possessing high sp. gr. and high refractive indices, which compounds are probably saturated polycyclical paraffins. The molecular weights of mineral oils determined in camphor are found to be generally lower than those determined in benzene. The ozonides from Texas and Pennsylvanian spindle oils have a characteristic pungent odour. When these oils are ozonised the ozonides fall out as a whitish flocculent precipitate, which gradually changes to red resin at temperatures of 20° C. or over. Oils poor in sulphur give more stable ozonides of a lighter colour. The curves of ozone absorption are very steep at their commencement. The maximum increase of weight by the absorption of ozone is 16 to 17%. The "white oils" show no formation of ozonides, but a considerable increase in viscosity when exposed to the action of ozone. On ozonising a Russian petroleum jelly a strong odour of vanilla was developed. Tables are given showing the properties of several ozonised oils and the distillation tests *in vacuo*, and graphs showing the relation of quantity of ozone absorbed to time of reaction. For ozonising, a modification of Liebig's potash apparatus was employed. The ozone value is subject to too great variations for employment in analysis, but a "splitting number" determined by taking the acidity of an ozonised oil which has been boiled for half-hour with water is of utility in the examination of transformer oils which have been in use. The determination of sludge values with ozone is much more rapid and convenient than with oxygen. The value is some four or five times greater than that obtained by the old method. A table is given showing the amount of ozone absorbed, the sludge value and the "splitting number" for transformer oil of gravity 0.915 for periods of reaction varying from 40 minutes to 5 hours. A standard method for the determination of the sludge value by ozone is proposed, and details of the cost of production of ozone are given.

H. M.

THE EXAMINATION OF BORING AND COOLING OILS (SOLUBLE OILS).—Th. Kaleta. *Chem.-Zeit.*, 1922, **46**, 783–784.

For the estimation of soap, mineral oil and fatty oil, 3–5 grms. of the sample are mixed with 100 cc. cold water in a beaker and precipitated

with solution of chloride of calcium as a lime soap. The precipitate is washed with water and acetone to free it from oil, then dissolved in hot benzol-alcohol mixture, and boiled with dilute hydrochloric acid. After cooling, the contents of the beaker are extracted with ether and washed with water. To the solution is added 50 cc. of neutral alcohol and it is titrated with n/2 alcoholic solution of potash, then evaporated and dried, and the resultant soap weighed. The filtrate is diluted with 100 cc. water and shaken 2–3 times with ether. The extract, which contains the mineral and the fatty oil, is washed with distilled water, and the ether evaporated off. The oils are saponified with 50 cc. of an alcoholic solution of potassium hydroxide, the alcohol evaporated, and 100 cc. water added. The mixture is warmed and the fatty oil precipitated as lime soap. This is filtered off, and the fatty oil determined as potash soap. The remaining mineral oil is extracted with ether, washed and filtered over dried calcium chloride. The ether is distilled off and the mineral oil weighed after drying. By another method the saponification value of the oil may be determined and a correction made for the free alkali in the soluble oil and the amount of the fatty oil so determined, the mineral oil being calculated by difference. The molecular weight of the fatty acids may be ascertained by the formula, potassium hydroxide used : gr. fatty acids : : 56 : molecular weight. H. M.

THE CHEMICAL COMPOSITION OF THE ESTHONIAN MIDDLE ORDOVICIAN OIL-BEARING MINERAL "KUKERSITE."—P. N. Kogerman. *Dorpat*, 1922.

"Kukersite" and the dictyonema shale form two layers of the Cambrian and Ordovician strata in the North of Esthonia. Though known as oil shales they are not true shales. In some places the shale lies near to the surface and is worked in open quarries. The immediate available supply of oil shale is estimated by the Esthonian Government at 1,500,000 tons. A review is given of former researches made on this oil shale from its discovery in 1789 to the present day. "Kukersite" rarely contains more than 35% of moisture, and after air-drying rarely more than 7%. Dried in a desiccator over sulphuric acid the moisture content remaining was about 2.38%. The ash content arises from 20–50%. The yield of volatiles was found to be 50.7 to 58.4%. The ultimate composition (on dry organic substance) was carbon 71.58%, hydrogen 7.40%, nitrogen 0.48%, sulphur 1.50%, and oxygen 19.04%. It was found that from 0.27% to 0.77% dissolved in eight various organic solvents, but in tetrachlorethane 2.20%, the time of extraction varying from 48 to 124 hours. By boiling in 20% solution of potassium hydroxide, neutralising and allowing to stand, a white precipitate not exceeding 4% of the weight of the shale was obtained; 10 grms. of shale heated to 250°–255° C. gave off 27 cc. of gas containing 8.7% of carbon dioxide, 0.6% of heavy hydrocarbons and 13.7% of carbon monoxide. Distillation at 600° C. gave 74.9 gals of oil, and 1,900 cub. ft. of gas per ton, and at 900° C., 49.7 gals. of oil and 7,200 cub. ft. of gas per ton. The crude tar obtained by distillation in retorts is a dark-brownish slightly fluorescent liquid of sp. gr. 0.939 at 17° C. By steam distillation 28.5% of light oil of 0.795 sp. gr. was obtained, which was found to contain about 60% of unsaturated open chain compounds. The quantity of cyclic unsaturated hydrocarbons in the crude tar was 55.5%. The heavy oil obtained by steam distillation contained 77% of such compounds. It is found that the oil shale "Kukersite" is formed from a soft cyanophycean alga. Under the action of chloral hydrate the algæ swell and take up their original form. H. M.

LABORATORY METHODS FOR THE EXAMINATION OF PARAFFIN WAX AND JELLIES.—E. Pyhälä. *Petroleum*, 1922, **18**, 1164–1165.

The sp. gr. is determined by the flotation of the wax or jelly in an alcohol-water solution. The substance is melted and dropped from a glass rod into warm alcohol. As the drops remain in a liquid state for a little while, it can be observed whether any air bubbles are present. The air-free drops are transferred to a measuring cylinder and water is then added till the alcohol-water solution is of the same sp. gr. as the drops, which then remain suspended in the liquid without rising or falling. The gravity of the solution at this point is then determined by the ordinary methods. The importance of insuring the absence of air bubbles in the substance under examination by the alcohol drop point test is emphasised. The effect of different methods of filling the glass vessel has been demonstrated experimentally, and it is shown that a variation of about 3° C. in the observed results may be caused by incorrect methods of filling. H. M.

A CONTRIBUTION TO THE GENESIS OF PETROLEUM. (THE NITROGEN COMPOUNDS OF PETROLEUM OILS IN GENERAL AND OF THOSE OF THE BAKU REGION IN PARTICULAR.)—E. Pyhälä. *Petroleum*, 1922, **18**, 1069–1073.

The acid sludge from the kerosene refining process of Baku petroleum is a tarry violet substance, smelling of sulphur dioxide and of terpenes. On diluting with water a violet oil separates, leaving a yellow acid solution, which on the addition of an excess of alkali gave a yellowish gray flocky precipitate. The precipitate was washed and dissolved in hydrochloric acid, a further quantity of violet oil separating. The solution is brown, but turns carmine colour after a few hours. A red, thick oil separated on the addition of common salt, and this was dissolved in chloroform and the solvent then distilled off. In distilling this oil a pale yellow oil came over between 60°–80° C. and afterwards some water, sulphide dioxide and turbid oil with odour of pyridine. Between 250°–270° C. the greater part of the substance distilled over as a substance similar to Canada balsam. This was dissolved in a little distilled water, filtered from a little dark oil, and evaporated at 80° C. A hygroscopic brittle mass was obtained smelling and tasting like quinoline, with an acid value of 261. This represents a nitrogen-containing body from the petroleum, possessing both acid and basic qualities, probably an amido-acid. In the distillation of the kerosene fractions of many kinds of petroleum a red to violet fugitive colouring is observed, and this is in proportion to the nitrogen content of the petroleum. Sulphur dioxide and water are also formed, though in small quantities. The filtration of a petroleum from Surachany through floridine left a red-coloured oil in the filtering medium by capillary analysis. The yellow filtrate was shaken with sulphuric acid and the precipitated acid sludge diluted with water, rendered alkaline with sodium hydroxide solution and shaken up with ether. The ether layer was yellow, but on distilling off the solvent a syrupy carmine red product remained, with a smell of quinoline and containing bases. The bases seem to consist of the hydrogenised derivatives of pyridine and quinoline, and are probably taken up by the petroleum from decomposed organic matter. H. M.

MONTAN WAX; CHLORINATION OF.—A. Deschauer U.S.P. 1,429,932. Sept. 26, 1922. Appl. May 22, 1922.

The chlorination is effected in aqueous mixtures. T. A. S.

FLASH POINT—IMPROVEMENTS IN APPARATUS FOR DETERMINING.—F. H. M. Klee. E.P. 185,814. Sept. 4, 1922. Appl., June 3, 1921.

The apparatus consists of an oil containing vessel surrounded by a jacket, the latter being electrically heated. A stirrer is provided for the oil and the vapours above the same. The ignition is by spark or coil heated to redness. The top can be removed for open cup tests. A modification consists of an electrically heated vessel in which high boiling oils of high flash may be dropped to determine their ignition temperature in the presence of heated air or oxygen.

T. A. S.

THE COMBUSTION OF FUELS IN THE INTERNAL COMBUSTION ENGINE.—T. Midgley, Jr. *J. Soc. Auto. Eng.*, **7**, 489–97.

The results of considerable research work into the behaviour of fuels in internal combustion engines particularly with regard to the phenomenon of "knocking" is reviewed. The opinion that "knocking" is due to the detonation of the gas charge is expressed. Fuels are arranged in order of their tendency to produce knocking as follows: ethers, paraffins, olefines, naphthenes, aromatics, alcohols. The theory of knock suppressors is discussed

T. A. S.

OIL PRODUCTION IN SOUTH AMERICA.—W. O. Fanning. *Oil and Gas J.*, **21**, No. 9, 11, 82 (1922).

Conditions obtaining in the oil industry in the South American countries are described. Peru produces two grades of oil, one of low and the other of high cold test. The latter is very similar to Pennsylvania crude.

T. A. S.

THE PRESENCE OF CARBONMONOXIDE IN NATURAL GAS FROM PETROLEUM.—E. Schmidt. *Mat. Grasses.* **14**, 6,157–60 (1922).

The presence of CO in neutral gas is shown to be due to the decomposition of naphthenic acids of petroleum. It is safe to assume that petroleum exists where natural gas containing CO is found.

T. A. S.

DETERMINATION OF TOLUENE, XYLENE AND BENZENE.—G. Zaborowski. *Mat. Grasses.* **14**, 6,160–1 (1922).

The determination of benzene, toluene and xylene in the commercial products or in gasoline mixtures may be carried out volumetrically by sulphonating with a known amount of H_2SO_4 and titrating the excess of acid. To about 3·5 gr. of the sample 3 times its weight (4 in the case of xylene) of preferably 100% H_2SO_4 is added. The mixture is warmed to 45°C. and shaken for 5 minutes. After allowing to cool it is poured into 100 ccm. of water, boiled to remove the light oils and titrated with standard NaOH and phenolphthalein acid used x 1·876 = toluene; acid used x 2·163 = xylene. In the case of benzene sulphonation has to be carried out under a reflux condenser. A densimetric method consists in determining the density of the mixture before and after sulphonation. The % is calculated from the formula $T = -[100\ D.\ (d_1 - d_2)]/(D - d_2)d_1$ where D is the d_{15} of pure toluene, benzene or xylene.

RESEARCH-CO-OPERATIVE. *J. Chem. Met. Eng.*, 1922, **27**, 12–591.

A scheme of co-operative research has been arrived at by the American Petroleum Institute and the American Chemical Society. The following list of problems of immediate utility and importance to the petroleum industry is to form the basis of an immediate research programme.

1. Thorough scientific investigation of fractionating columns.

2. Preparation of rational specifications for petroleum products based upon the results of actual research work. More rational volatility specifications for gasoline and tests for the "oiliness" property of lubricants.

3. Investigations as to the actual need of highly refined gasoline for motor fuel; is it necessary to remove bad smelling sulphur compounds completely in order to obtain efficient service from gasoline? Will these compounds injure the engine?

4. A study of the fundamental causes of carbon formation in cylinders; elimination of polymerised products in cylinders; study effect of additions of peroxides, naphthalene, picric acid, phenanthrene, pyrene picene, cyclohexanol, phenol, etc.

5. Through study of lubrication from a colloid chemical standpoint.

T. A. S.

EXCLUDING WATER FROM OIL AND GAS WELLS.—R. V. Mills. U.S.P. 1,421,706. July 4, 1922.

An impervious precipitate is formed in the walls of the well by the introduction of suitable chemicals, *e.g.*, sodium silicate and magnesium chloride or calcium chloride or hydrochloric acid. T. A. S.

FATTY ACIDS, ALDEHYDES AND KETONES FROM MINERAL OR TAR OILS.—C. Harries. G.P. 339,562.

The raw oils are first treated with liquid SO_2 to remove the portion soluble therein. The residue is cooled to partial solidification and the liquid portion separated and fractionated with steam. The fraction boiling between 100–200° C/10 mm. is treated with ozone until an increase in weight of 8·12% is obtained. On treatment with superheated steam the peroxides in the oxidised oil are decomposed and the acids are separated as soaps on treatment with hot concentrated KOH. The soaps on hydrolysis give principally stearic and palmitic acids. In order to obtain aldehydes and ketones the oxidised oil after treatment with steam is shaken with $NaHSO_3$ soln. and the aldehydes and ketones separated as bisulphite compounds. A large number of aldehydes and ketones boiling over a large range are obtained. A yield of aldehydes and ketones up to 80% may be obtained. The residual oil is no longer oxidisable. T. A. S.

INFLUENCE OF THE ELEMENTS OF THE OXYGEN GROUP ON PARAFFIN.—H. Siebeneck. *Petroleum Z.* (1922) **18**, 281–6.

Air and oxygen both attack paraffin when bubbled through it at 135° C. After 10 hours acid vapours are evolved and after 22 hours the product contains 30–40% of saponifiable matter according as air or oxygen is used. Saponifiable matter to the extent of 52·65% with an acid value of 59·03 and an ester value of 93·91 can be obtained. This indicates 30% and 70% esterified acids. The fatty acids produced are saturated. The volative products amount to about 7% of the paraffin used and consists of lower members of the same series with water. When

paraffin wax is heated with sulphur H_2S is evolved at 150° C. It is evolved more freely at 230° C. and CS_2 is also formed. After 7 hours treatment at this temperature all the hydrogen has been replaced and an amorphous black product can be isolated from the brownish black residue by extraction first with CS_2 and then with ether. The black product corresponds closely with the formula $(C_8S)_x$. This substance does not react with alkalies, but is attacked by strong sulphuric or nitric acids. Similar results were obtained with Se and Te, but no compound analogous to the sulphur compound was isolated. Small quantities of sulphur or Se inhibit the action of oxygen on paraffin.

T. A. S.

ARTIFICIAL PETROLEUM FROM SOYBEAN, COCONUT AND CHRYSALIS OILS AND STEARIN.—K. Koboyashi.

A mixture of the oil and powdered Japanese acid clay is charged into an iron retort and covered with the same clay. Distillation is carried out at ordinary pressures and is complete at about 700° C. The distillate has a greenish fluorescence and is similar in odour to the artificial petroleum obtained from fish oil. Coconut oil (sp. gr.—·9294 sap. val. 253·5) produced 54·7% distillate (sp. gr.— ·8176. sap. val. 83·5) which gave 9·67 light oil (sp. gr.—·7679. sap. val. 11·0), 34·7% of illuminating oil (sp. gr.—·8244. sap. val. 68·1) and 10·4% of neutral heavy oil (sp. gr. —·9060. sap. val. 89·3).

T. A. S.

THE WATER OF THE GROSNI PETROLEUM WELLS.—By V. A. Seylsky. *The Journal of Grosni Petroleum Industry, No. 4, July, 1922, p. 26.*

The important part which water plays in the exploration of petroleum wells should be scientifically investigated in order to define which strata is responsible for the access of the water to the well.

In boring new wells, or deepening old ones, little notice has been taken of the condition of the neighbouring wells, with the result that very often a good productive well has been flooded by water. The exact decision of the question as to the source of the water does not only depend on the analysis of the water, but also on the analysis of the strata through which the water passes, and also from geothermical observations. If the temperature of the water is equal to the temperature of the strata from which it was received, we can then assume that the water comes from that particular strata; but if the water is lower than that of the strata, then it shows that it is penetrating from the upper strata. And, finally, if the temperature of the water is higher than that of the strata from which it was taken, then it is possible that the water penetrates through cracks from below.

The Grosni Petroleum Fields show that their formation is due to a complicated process, the chief of which is pressure. As the result of a mechanical action the hard strata had been covered by a whole series of cracks, and thus any liquid is enabled to move among them for a very long distance. The author comes to the conclusion that, in order to examine the origin of the water in the petroleum wells it is necessary:—

1. Carefully to examine the chemical and stratagraphical composition of the rocks.

2. Systematical and complete analysis of the water from the wells from each horizon, giving the temperature of the water, as taken from that particular depth.

3. Careful examination of the boundary of that region where water has appeared.

4. Determination of the exact situation of the cracks in the strata, or to determine the condition under which water shows its appearance, and investigating the laws of the movements of water by means of experiments, and observations on the water and petroleum-carrying horizons.

In view of the very scarce publications of the analysis of water from petroleum wells, it is of interest to give the various analysis obtained in the Grosni Oil Fields, which is as follows :—

No. of Plot	23	63	42	20	72
,, ,, Boring ..	4	6	1	5	10
Depth	—	1787′	259′	1302′	2337′
Sp. gr.	1·0035	1·0011	1·0023	1·008	1·0021
Hardness	2.37	—	—	4.16	—
Alkali	10·6	6·45	4·5	24·2	4·6
Dry residue	2·4786	1·1	1·0554	13·899	1·036
C_2O	0·2287	0·048	0·0414	0·1708	0·274
M_gO	traces	0·0047	0·0049	0·1659	0·025
$Fe_2O_3 + Al_2O_3$ ..	0·0042	—	0·044	0·0056	0·0024
Cl.	0·858	0·1753	0·1188	4·3238	0·117
SO_3	0·29	0·4554	0·3139	0·1422	0·6139
SiO_2	0·011	0·024	0·0394	0·0224	0·05

Plot	34	114	22	38	44	37
Boring	5	21	6	1	6	3
Depth	1473′	—	1260′	1512′	—	1057′
Sp. gr.	1·0319	1·0078	1·0167	1·0187	1·018	1·0232
Hardness ..	180·37	4·23	116	65·63	47·49	120
Alkali	14·4	95·12	24·57	—	—	4·7
Dry residue ..	44·5	11·868	22·486	28·4204	25·58	30·946
C_2O	0·65	0·03	0·672	0·5332	0·204	0·2369
M_gO	0·83	0·0159	0·3577	0·0785	0·1947	0·6484
$Fe_2O_3 + Al_2O_3$	0·0146	0·0152	0·0032	0·006	0·0128	0·014
SiO_2	0·0232	0·0124	0·0452	0·052	0·252	0·0136
Cl.	25·578	2·536	12·206	14·51	13·97	18·5
SO_3	—	—	—	—	—	—

Plot	29	22	45	59	2	24
Boring	1	4	2	11	1	14
Depth	—	1246′	—	770′	1302′	1274′
Sp. gr.	1·004	1·0048	1·01	1·0036	1·0193	1·008
Hardness ..	2·08	35·88	17·84	34·04	125·2	—
Alkali	65·1	43·8	—	15·3	31	27·98
Dry residue ..	4·0434	5·9884	8·464	1·9966	25·85	0·086
C_2O	0·0152	0·2992	0·12	0·0122	0·559	0·067
M_gO	0·004	0·0421	0·042	0·0156	0·0986	0·1249
$Al_2O_3 + Fe_2O_3$	0·0018	0·002	0·0204	0·005	0·0108	0·0074
SiO_2	0·0326	0·0312	0·0944	0·0234	0·0552	0·0586
Cl.	0·2952	1·6489	4·195	0·0303	1·404	1·82
SO_3	—	—	—	—	—	0·108

P. D.

ANALYSIS OF CZECHOSLOVAKIAN PETROLEUM.—F. Schulz. *Petroleum Z.*, 1922. **18**. 321–3.

Gbely petroleum is distinguished by the fraction boiling from 150–200° C. which has a terpene-like odour and is similar to certain types of Louisiana oil The odour is due to the presence of compounds of the series C_nH_{2n-2}, and not to terpenes. The oil is optically active

and contains no wax. On distillation with superheated steam the flash point of both distillate and residue rise slowly and the latter soon acquires high viscosity which is not due to the formation of asphalt. Oils from Bohnslavice, Mikova and Turzovka resemble the best Pennsylvania crude and contain practically no asphalt and but 0·025% sulphur. On distillation up to 300° C. a light transparent residue of vaseline is obtained setting at 26–28° C. Hodonin oil is identical with Gbely oil. T. A. S.

Cracking Processes.

Cracking Hydrocarbon Oils—Process and Apparatus for.—J. L. Murrie. U.S.P., 1,435,652. Nov. 14, 1922.

Hydrocarbon oils, preferably mixed with fixed hydrocarbon gases produced in the cracking process, are passed through molten metal kept at the desired temperature in a trough-shaped bath which is of larger cross section at the top than at the bottom, thereby obviating excessive commotion of the metal. The preheated oil is introduced through a plurality of small pipes entering towards the bottom of the trough and the heavy unvaporised portion, together with carbon, is drawn off continuously from the surface of the metal through a conduit which can be adjusted to alter the depth of the oily layer. The vaporised portion of the oil is fractionally condensed, and the heavier portions returned for recracking. The troughs are provided with covers and means are supplied of operating under pressures up to 125 lbs. per sq. in. Owing to the continuous removal of carbon and heavy oil from the reaction chamber the process can be run without interruption. F. G. P. R.

Petrol, Improvements Relating to Production of.—F. Tinker. E.P. 188,058. July 29, 1921.

Crude oil, which has been preheated by hot residues and partially by direct heating, is passed into a mixing chamber where it is mixed with the superheated gases from a cracking chamber. The vapours are lead to a fractionating column, from which heavy residues are returned to a still and thence to the cracking chamber. T. A. S.

Hydrocarbon Compounds—Method and Apparatus for Treating.—W. J. Knox, Assr. to E. D. Warren. U.S.P. 1,428,641, Sept. 12, 1922. Appl., March, 24, 1919.

Hydrocarbon vapours are cracked by heating to a high temperature. The hot cracked gases before condensation are passed over the surface of oil to heat the same and to remove low-boiling constituents. T. A. S.

Hydrocarbon Liquids, Fluids and Oils; Process of Conversion into Lower Boiling.—J. H. Adams. A.P. 1,433,519, Oct. 24, 1922. Appl., Dec. 5, 1917. Orig. Appl., Dec. 1, 1909.

Lower-boiling hydrocarbons are obtained by passing oil through a succession of heating chambers. Pressure is maintained in each chamber and the vapours formed are removed. T. A. S.

CRACKING PETROLEUM.—K. Smolenski, S. Turowicz and R. Dobroweski. *Przemysl Chem.* 1921. 201–20, 237–54.

Krosno petroleum yields aromatic hydrocarbons in quantities approaching those obtained from Baku petroleum. The temperature of distillation has an important effect on the quality and quantity of the products. 680–720° C. appears to be the most satisfactory temperature, and with a given rate of flow benzene, toluene, xylene, naphthalene and anthracene are readily obtained.

T. A. S.

HYDROCARBONS—METHOD AND APPARATUS FOR PRODUCING.—W. Munder, Assr. to the Chemical Foundation. U.S.P. 1,431,246. Oct. 10, 1922. Appl., Jan. 31, 1915.

Light hydrocarbons free from asphalt and sulphur are produced by subjecting heavy hydrocarbons to distillation under ordinary pressure. The distillate is then heated under pressure with continuous distillation, in an autoclave.

T. A. S.

LOWER-BOILING HYDROCARBONS—PROCESS AND APPARATUS FOR PRODUCTION OF.—J. C. Black. U.S.P. 1,431,772, Oct. 10, 1922. Appl., Aug. 15, 1921.

Oil is cracked by passing it through a coil, heated to cracking temperature and maintaining it at this temperature for some time in a "digester" of larger cross sectional area than the cracking coil. The oil is then passed through chambers where the pressure is successively diminished to cause the vaporisation of the various fractions.

T. A. S.

OILS—APPARATUS FOR CRACKING.—W. B. D. Penniman. U.S.P. 1,429,622, Sept. 19, 1922. Appl., April 25, 1917.

Stills in series are internally heated by means of a hot fluid, the fluid supply being thermostatically controlled. Oil is passed through the system in the opposite direction to the hot fluid flow.

T. A. S.

PETROLEUM OIL—PROCESS OF HEATING, FOR CRACKING.—R. Cross, Assr. to Gasoline Products Co. U.S.P. 1,423,500, July 18, 1922. May 2, 1921.

Oil is heated to cracking temperature by passing it through a tube heated in a furnace. After leaving the tube the oil is maintained at cracking temperature, under the pressure of the evolved gases, in an insulated "reacting chamber." The process is continuous, oil and gas being continuously removed from the reacting chamber. Cracking takes place in the liquid phase.

T. A. S.

HYDROCARBONS—PROCESS OF CONVERSION.—H. R. Berry. U.S.P. 1,429,910, Sept. 19, 1922. Appl., Aug. 10, 1922.

Heated hydrogen gas-carrying hydrocarbon vapours is caused to flow counter-current to films of relatively cool oil. The pressures and temperatures are so controlled that lower-boiling hydrocarbons are produced without the formation of carbon deposit.

T. A. S.

OILS—APPARATUS FOR CRACKING.—W. B. Penniman. U.S.P. 1,429,623, Sept. 19, 1922. Appl., May 5, 1917.

Oil is heated in a still by means of a steam coil. The vapours from the still pass through two chambers containing steam coils. The supply of steam to the various parts of the apparatus is thermostatically controlled.

T. A. S.

HYDROCARBONS—PROCESS FOR PRODUCING LIGHTER FROM HEAVIER.—C. V. Woegerer, Assr. to J. R. and W. H. Clarke. U.S.P. 1,429,992, Sept. 26, 1922. Appl., May 8, 1920.

Hydrocarbons are cracked by atomising them with water and lime and then with steam under pressure and at a temperature below 500° F. They are then allowed to settle under pressure to allow unconverted oil and lime to settle out and finally condensed under pressure.

T. A. S.

HYDROCARBON—METHOD OF SEPARATING FROM ALUMINIUM CHLORIDE.—E. V. Owen, Assr. to the Hoover Co. U.S.P. 1,430,109, Sept. 26, 1922. Appl., Jan. 21, 1922.

"Aluminium Chloride-hydrocarbon" is delivered to a bath of liquid material maintained at a temperature sufficiently high to vaporise the aluminium chloride but not the hydrocarbon.

T. A. S.

CRACKING AND DISTILLING OIL—PROCESS FOR.—J. T. Fenton. U.S.P. 1,394,481, Oct. 18, 1921. Appl., May 1, 1920.

Oil is cracked by direct treatment in an atomised state and under pressure with superheated steam. The supply of steam is so controlled that only a portion of the oil is cracked. The treated oil is passed to a separator where by reduction of pressure the lighter fractions are removed and subjected to fractional condensation.

T. A. S.

HYDROCARBON PRODUCTS—PROCESS FOR PRODUCING.—C. L. Lightenhome, Assr. to Lightenhome Oil and Refining Co. U.S.P. 1,434,300, Oct. 31, 1922. Appl., Sept. 14, 1917.

Heavy hydrocarbons are cracked by subjecting them to the action of steam and finely-divided lime at a temperature and pressure below that at which permanent gases are formed and for a time sufficiently long for cracking to take place.

T. A. S.

HYDROCARBON OILS—APPARATUS FOR CRACKING.—F. T. Manley, Assr. to The Texas Co. U.S.P. 1,428,338-9, Sept. 5, 1922. Appl., Oct. 10, 1917.

(1) Oil is cracked by heating in a vertical still under pressure. Fresh oil is introduced into the bottom portion of the still, which is kept cold. The vapours evolved are passed through a dephlegmator, the heavy portions being returned into the bottom of the still with the fresh oil.

(2) Hydrocarbon oils of comparatively low boiling point are cracked by bringing them in contact with a horizontally-elongated body of hydrocarbon oil of higher-boiling point heated to a temperature sufficiently high to crack the lower-boiling oil. The vapours of the

lower-boiling oil are caused to pass along the surface of higher-boiling oil and overheating is prevented.

T. A. S.

NATURAL GAS—PROCESS OF TREATING AND PRODUCT.—H. E. Thompson, Assr. to Carbide and Carbon Chemicals Corpn. U.S.P. 1,429,175, Sept. 12, 1922. Appl., Aug. 29, 1921.

A liquid of predetermined vapour pressure is separated from a mixture of natural gas hydrocarbons by separating from the mixture a fraction having a higher vapour-pressure than that desired. This fraction is rectified to produce vaporous and liquid portions, the rectification being so conducted that not more than one hydrocarbon of the fraction will occur in substantial quantity in both the liquid and the vaporous portions.

The product is a natural gasoline having a density not less than 87°Be and a vapour tension not substantially greater than 12 lbs. at 100°F.

T. A. S.

HYDROCARBONS OR OTHER OILS—IMPROVED APPARATUS FOR CRACKING.—A. A. F. M. Seigle. E.P. 185,140. Aug. 24, 1922. Appl., Feb. 24, 1921.

Hydrocarbon oil is vaporized at 650°C. and a pressure of 12 hectogrammes per sq. cm. in a tube. This tube is packed with aluminium and iron turnings, the portions packed with aluminium being heated only up to 450°C. The vapours are then expanded and cooled in chambers packed with metal turnings. Iron turnings are active at 650°C., aluminium at 450°C., copper at 300-500°C., and ferro nickel at 200-350°C. The expansion chambers are maintained at the desired temperatures by jacketing with water boiling under the necessary pressure. Two expansion chambers are used, one working at 260°C. and the other at 160°C. Certain heavy oils condense in the expansion vessels and are withdrawn from the bottom.

The vapours enter the first expansion chamber at the temperature and pressure at which they leave the vaporizing tube and leave the chamber at about 260°C. and 4 hectogrammes per sq. cm. They are then again compressed and enter the second chamber at 300°C. and 9 hectogrammes per sq. cm., leaving at 160°C. and 2 or 3 hectogrammes per sq. cm. The products of the apparatus are rich gas, light hydrocarbons and heavy oils suitable for use as lubricants. The quantity of light hydrocarbon can be increased by using suitable catalysers in the second expansion chamber and repassing through it some of the rich gas along with hydrogen. The apparatus is designed to work on oil not boiling below 200-250°C.

T. A. S.

OILS; PROCESS FOR CONVERSION OF.—J. H. Adams, Assr. to The Texas Co. U.S.P. 1,428,311-2. Sept. 5, 1922. Appl., June 25, 1918.

(1) Hot high boiling hydrocarbons are sprayed by means of superheated steam into a chamber, the steam being heated to a temperature sufficient to crack the oil. The heavy residues are collected in the bottom of the chamber and the evolved lighter vapours are withdrawn from the upper portion.

(2) Hot oil is sprayed along with superheated steam into an expansion chamber consisting of spaced chambers with a communicating passage, the passage being heated. The cracked vapours are removed through a condenser. The apparatus is maintained at pressures higher than atmospheric.

T. A. S.

CRACKING HYDROCARBONS, PROCESS OF AND APPARATUS FOR.—F. G. Niece. E.P. 185,632. Sept. 14, 1922. Appl., Sept. 7, 1921.

Heavy oil is cracked by passing it through molten metal under pressure. The metal, *e.g.* lead, is contained in a long vertical tube and preheated oil is introduced at the bottom. The vapours from the apparatus are condensed under pressure and any uncondensible gases are returned to lower portion of the cracking apparatus and passed through the molten metal along with the oil under treatment. Distribution of the oil and vapours in the molten metal is brought about by means of baffles.

T. A. S.

OIL CRACKING. PROCESS AND APPARATUS FOR.—C. A. Jensen. Communicated by J. A. Stone. E.P. 185,624. Sept. 14, 1922. Appl., Aug. 27, 1921.

The apparatus consists of two concentric cylinders packed with catalytic absorbent or spreading material. Oil is cracked in the inner cylinder, the outer cylinder being gas-fired for heating purposes. When the inner cylinder ceases to operate owing to deposition of carbon, etc., the oil to be cracked is introduced into the outer cylinder and the inner cylinder is fired for heating purposes. The apparatus can be made to work with or without pressure. Suitable catalytic materials are cast-iron or nickel or porous fire-clay or fullers earth. Efficient double-phase cracking is claimed.

T. A. S.

CRACKED PETROLEUM OILS AND PROCESS AND APPARATUS FOR.—L. W. Goold. Communicated by Universal Oil Products Co. E.P. 185,439. Sept. 11, 1922. Appl., Mar. 11, 1921.

Oil is cracked at a temperature less than 875°F. and a pressure of 135 lbs. per sq. in. by being circulated in a system consisting of a heating coil built up from 20 ft. sections of 4 in. pipe and being about 400 ft. long and an expansion chamber made up of four 20 ft. sections of 10 in. pipe. Any deposition of carbon takes place in the expansion chamber, which is readily accessible for cleaning. The vapours from the expansion chamber are led off to a dephlegmator and any reflux condensate is taken back to the heating coil. A pressure distillate is obtained, when working on crude oil residues, having a lower percentage of unsaturated hydrocarbons than the charging stock and consisting of not less than 15% each of gasoline and kerosene.

T. A. S.

MOTOR FUELS.

ALCOHOL FUELS—IMPROVEMENT RELATING TO.—S. W. Blake. E.P. 187,335. July 19, 1921.

A previous specification, No. 178,498 (*J.*, 1922. 454A) describes the preparation of a fuel of high volatility and calorific value, by treating a mixture of commercial alcohol and acetone in a pressure vessel with calcium carbide, the acetylene formed being absorbed. In the present specification other monohydric alcohols, *e.g.*, amyl, butyl and propyl alcohols are used and yield satisfactory fuel. It is advantageous to retain approximately 10% of water in the fuel and to remove all lime. The alcohol used should be of low strength, *e.g.*, 90–92%. The presence of water in the fuel keeps the engine cooler and prevents carbonisation and consequent knocking. When preparing the fuel from the heavier alcohols the water should be added to the acetone and the acetone-water

mixture then added to the alcohol. The proportion of acetone is from 5 to 40%, and the proportion of calcium carbide used from ¼ to ½ lb. per gal. The removal of lime is effected by adding ammonia and then passing CO_2 through the solution. T. A. S.

FUEL FOR INTERNAL-COMBUSTION ENGINES.—D. F. Field. Communicated to H. R. Giles. E.P. 187,326. July 18, 1921.

Alcohol-ether fuels, owing to the formation of acetic acid and other causes, are unsatisfactory. The difficulties are overcome by the addition of rosin oil and a small proportion of caustic soda dissolved in alcohol. A mixture consisting of alcohol (66 o.p.) 36.75%, ether 62%, rosin oil 1%, saturated solution of caustic soda in alcohol .25% is satisfactory when used in a carburettor normally adjusted for use of petrol. T. A. S.

SULPHUR—EFFECTS IN FUEL OIL.—A. F. Brewer. *Power*, 1922 **55**, 50–1.

Several precautions to be adopted to minimise the detrimental effects of sulphur in fuel oils, which are due to the formation of sulphuric acid, are suggested. The oil should be as free as possible from water and the amount of steam used for atomising should be the minimum. Shut-down should be avoided and tubes blown frequently to prevent sooting.
T. A. S.

MOTOR FUEL FROM PETROLEUM.—O. P. Amend. U.S.P. 1,423,064. July 18, 1922.

A fuel obtained by cracking heavy oil with catalysts has the following characteristics: Sp. gr. above .74, Br absorption No. above 125, flash point below 0° F. Over 50% is volatile below 80° C. It contains not less than 30% of naphthenes, and is free from terpenes or resinous substances.
T. A. S.

CARBURETTOR CONTROL BY EXHAUST GAS ANALYSIS.—Jones and Fieldner. Paper before Petroleum Section of Amer. Chem. Soc. *J. Chem. Met. Eng.*, 1922 **27**, 13, 590–1.

Considerable fuel economy can be effected by the aid of exhaust gas analysis in controlling carburettor setting. An increase in mileage of 20% on Government trucks was effected by this method. The average of several thousand analyses from 101 cars showed 70% combustion.
T. A, S.

SULPHUR IN FUEL.—C. O. Johns. Paper before Petroleum Section of Amer. Chem. Soc. *J. Chem. Met. Eng.*, 1922 **27**, 12, 590.

A Diesel engine was run on fuels such as Mexican crude, gas oil, and a polymerised by-product of alcohol manufacture, containing 19% of combined sulphur. The Diesel engine was run for 400 hours at a compression of 500 lb. Frequent examinations of the engine showed no evidences of corrosion. Some trouble was encountered by excessive formation of carbon deposits around the exhaust valve. T. A. S.

LIQUID FUEL RESEMBLING PETROLEUM PREPARED BY DRY DISTILLATION OF CA-SALTS OF SOY-BEAN FATTY ACIDS.—M. Sato. *J. Chem. Ind.* (*Japan*), 1922 **25**, 13–24.

100 g. of Ca salt of soy-bean fatty acids yields on distillation 73 gr. of oil and 8 litres of gas. The oily distillate has an odour resembling that of cracked petroleum, is greenish yellow and fluorescent. It has a sp gr. of .8261, iodine value, 117.4; acid value, 0.3, and loses 22% by

volume when treated with concentrated sulphuric acid. Its calorific value is 9956 cals. The gas contains CO_2 2.4%, O_2 4%, heavy hydrocarbons 18.1%, CO 10.3%, H_2 1.4%, CH_4 50.7% and nitrogen 12.3%. T. A. S.

ALCOHOL-ETHER MIXTURES; IMPROVED MANUFACTURE OF.—F. E. Lichtenthaeler. Communicated to H. Wade. E.P. (A) 187,051, (B) 187,052. July 27, 1921.

(A). The difficulty of preparing alcohol-ether mixtures when the ether is separately prepared, is considerable, owing to the high volatility of the ether. The necessity for the provision of special condensing and refrigerating plant has been overcome by passing the vapours obtained in the manufacture of ether from alcohol and sulphuric acid through a scrubber containing alkali, and thence through an absorbing tower, within which a stream of alcohol is flowing in a counter current direction to the ether vapours. A certain amount of the ether is condensed before the vapours enter the absorbing tower, and this is added to the weak alcohol-ether mixture, obtained in the tower, to give the desired mixture suitable for motor fuel. By this means the handling of the ether as such is avoided, and the alcohol-ether mixture has no more fire risks than ordinary petrol.

(B). Alcohol-ether mixtures are prepared direct from raw material, containing sugars or starches, alcohol never being stored as such in bulk. Fermented mash is distilled and concentrated in a continuous still up to approximately 95%. A portion of the alcohol so obtained is led off to an ether making apparatus and converted into ether. The remainder of the alcohol from the continuous still is taken to an absorbing tower to absorb the purified ether vapours. T. A. S.

BURNING HYDROCARBON OILS—IMPROVED METHOD AND APPARATUS FOR.—C. E. Chapman and J. Goodfellow. E.P. 186,446. July 6, 1921.

Complete combustion of heavy hydrocarbon oil is attained by atomising it with superheated steam into a retort-like device, which is jacketed for cooling purposes. The retort is fitted with a discharge horn having a bell mouth, from which the flame enters the furnace, first impinging on the superheater supplying steam to the atomiser. Part of the products of combustion are circulated through the retort along with the incoming atomised oil. The retort and horn are lined with refractory material. T. A. S.

ALCOHOLIC LIQUID FUEL (NON-POTABLE)—PROCESS AND APPARATUS FOR.—F. de M. Accioly. E.P. 187,640. April 20, 1921.

A non-potable alcoholic fuel is prepared from the saccharine juices of a large variety of plants. To a 1000 litres of juice is added yeast 200 gr., tannin 100 gr., neutral potassium tartrate 1000 gr., sulphuric acid 100 gr. The mixture is then fermented at 15–30° C. in a closed vessel. To the fermented liquid is added a mixture of 500 gr. boiled orange peel, 60 gr. Stockholm or petroleum tar, 40 gr. powdered naphthalene, 125 gr. sulphuric acid, and 2 gallons water. The whole mixture is then distilled. To the alcohol so obtained is added a mixture consisting of turpentine 500 gr., ether 1000 gr., naphtha (sp. gr. 0.800) 3000 gr., animal or vegetable or mineral oil 500 gr., hydrochloric acid 150 gr., Stockholm or petroleum tar 50 gr., naphthalene 20 gr., and the whole is again distilled. When saccharine juices are not available they may be replaced by alcohol of 20–40° Bé. T. A. S.

LIQUID FUEL—METHOD OF FORMING.—A. Hayes. Assr. to U.S. Industrial Alcohol Co. U.S.P. 1,428,885, Sept. 12, 1922. (Appl. June 5, 1919.)

A mixture consisting mainly of heavy hydrocarbon oil and alcohol, and containing small proportions of light hydrocarbon and ether, is converted into a fuel of a non-stratifying character, by vaporising the mixture and passing the vapours through a finely-divided zinc or nickel catalyst, maintained at a temperature below about 300° C. T. A. S.

DISTILLATION AND REFINING.

SULPHURIC ACID RECOVERY IN OIL REFINERIES.—L. B. Skinner. *Chem. Met. Eng.*, 1922, **27**, No. 15. 734–6.

In early days the acid was concentrated in lead pans to 60° Bé, and then brought to 66° in glass retorts or stills. Owing to breakages platinum stills with lead covers were tried, but found too costly, and eventually cast-iron stills with conical lead covers became general. With the addition of modern towers of packed brick to absorb the fumes this form of concentration is still advantageous in small refineries owing to low initial cost. Where large amounts of acid have to be worked up tower concentrators are the most efficient. Four towers packed with brick are employed, one for evaporating weak acid, one for concentrating to 66° Bé, and two attached to the latter to trap the acid fumes. Heat is supplied by flue gases from oil burners, which pass up the towers in counter current to the descending acid. Details of construction and working of the plant are given. For producing 25 tons of 66° Bé acid daily the plant should cost approximately £8,000. F. G. P. R.

SLUDGE ACIDS—METHOD OF TREATING.—I. Hechenbleikner and T. C. Oliver. Assrs. to Chemical Construction Co. U.S.P. 1,429,140, Sept. 12, 1922. (Appl. Jan. 7, 1922.)

Sludge acids or separated sludge acids are first preheated to drive off the volatile impurities and then concentrated by further heating.
T. A. S.

DESIGN AND OPERATION OF A LOW-PRESSURE ABSORPTION PLANT.—W. P. Dykema and A. A. Chenoweth. *U.S. Bureau of Mines, Technical Paper* 263.

The plant described was put in in 1916–1917, on the Cushing oilfield in Oklahoma, and takes the gas from thirty wells. It deals with 2,000,000 cub. ft. of gas daily, averaging 3½ galls. per thousand. Scrubbers are installed on the suctions of four vacuum pumps. At the commencement of operation no vacuum was put on the wells, but later on the pressure was lowered to 15, and then to 19–20 inches of mercury, with a considerably increased production. A pressure of 4–6 lbs. is maintained in the towers. The absorption towers are worked in series, though designed to work in parallel. The gas is cooled by passing through pipes sprayed with water before going to the towers. The towers are occupied by wood strips, which effect a fine distribution of the oil. The velocity of flow of the gas in unbaffled parts of the towers is 7.5 ft. per minute, at maximum rate of flow; in baffled parts 15 ft. per minute. The oil circulation is maintained at 100 galls. per minute. The gas, after passing through the absorption towers, has a low gasoline content of 0.055 gall. per 1000 cub. ft., but its heat value is still 1900–2000 B.Th.U. The gasoline has a gravity of 96° B., an initial boiling point of 60° F., and an end point of 226° F., and contains a large proportion of very volatile and absorbed

permanent gases. Distillations of gasolines from various points in the system are given. After the gas has passed through the towers it is compressed and discharged into the service lines. The yield of gasoline per 1000 cub. ft. has attained 8.45 galls. The absorbing oil is a gas oil of 35–37 B. gravity. The absorption oil after discharge from the evaporator of the still, passes through three tubular heat exchangers. Graphs showing heat exchange are given, as also drawings illustrating details of plant, and tables showing results of working. H. M.

STILL.—E. W. Isom & J. E. Bell. Assrs. to Sinclair Refining Co. A.P. 1,432,067, Oct. 17, 1922. (Appl. May 12, 1921.)

The still consists of a heating unit, through which oil is pumped and a larger receptacle. The support for the pump is flexible to permit of movement with expansion and contraction of the pipework. T. A. S.

PETROLEUM, SHALE AND COAL TAR HYDROCARBONS—PROCESS OF REFINING.—W. C. Wells & F. E. Wells. A.P. 1,433,052. (Appl. Oct. 27, 1919.)

The oil is heated in a still, the bottom of which is covered with an inert fusible material. Permanent neutral gas is passed through and the resulting mixed vapours are passed upwards through fuller's earth, which is maintained at a lower temperature than the oil in the still. The vapours are then condensed. The apparatus can be made to work continuously, and the inert gas can be used repeatedly. T. A. S.

VAPOURS, PROCESS OF FILTERING.—W. C. Wells & F. E. Wells. A.P. 1,433,050, Oct. 24, 1922. (Appl. Feb. 15, 1919.)

Oil is heated in a still, permanent neutral gas being passed through it. The resulting vapourous mixture is passed upwards through a filtering material, such as fuller's earth, which removes colour and bituminous material. The filtering material is maintained at a lower temperature than the oil, and after passing through it the vapours are condensed. T. A. S.

VAPOURS—RECOVERY FROM GAS MIXTURES.—C. L. Voress & V. C. Canter. U.S.P. 1,420,613, June 20, 1922.

Vapours of gasoline, benzine, alcohol or ether are recovered by the use of a solid absorbent, *e.g.*, charcoal or silica-gel. The absorbed vapours are removed by treating with absorbent with steam. T. A. S.

DECOLORISING EFFICIENCY OF FULLER'S EARTH.—L. W. Parsons & L. R. Churchill. Paper before Petroleum Section of Amer. Chem. Soc. *J. Chem. Met. Eng.*, 1922, **27**, 12, 590.

A rapid test for the decolorising value of fuller's earth is based on the relationship between this property and the reactivity between fuller's earth and some unsaturated bodies. Pinene is polymerised in contact with fuller's earth with considerable heat development. The temperature rise serves as a convenient measure of the decolorising value of various clays. T. A. S.

DISTILLING AND REFINING.

USE OF BLEACHING POWDER FOR SWEETENING GASOLINE.—H. W. Young and A. W. Peake. *Chem. Met. Eng.*, 1922, **27**, 20, 972–6.

A blended gasoline consisting partly of natural gas gasoline and partly of naphtha topped from crude is treated with a solution of bleaching

powder. The consumption of bleaching powder is about 2.75 lbs. per 1000 gal. The efficiency of the solution is increased by aerating a portion of it and loss of chlorine is avoided by using the solution several times, fresh bleaching powder being added. The gasolene is refined to give a negative doctor test. Corrosion in the plant is not serious, some parts becoming protected by a coat of calcium sulphate. The use of galvanised pipe lines is recommended. Any emulsion formed should be treated in a lead-lined tank with hydrochloric or sulphuric acid. T. A. S.

Distillation of Strongly-Frothing Substances.—Klänhardt. *Chem. Ztg.*, 1922, **46**, 493.

CO_2 is delivered from a perforated bulb suspended just above the surface of the liquid that is being distilled and is efficient in breaking the foam. T. A. S.

Settings for Stills and Similar Purposes; Improvements Relating to. —P. Mather. E.P. 186,849, Oct. 12, 1922.

The setting particularly relates to long vertical stills that it is desired to heat uniformly and in regulable zones. The brickwork setting for vertical cylindrical still is of substantially the same form as the still, and is divided to form a series of annular flues round the still. A series of liquid fuel or gas burners are arranged on one side of the setting, and a vertical flue connected with all the annular flues on the other. A layer of non-conducting material is placed between the fire-brick lining of the annular flues and the ordinary brickwork backing of the setting. The casing of the still opposite the burners is protected by fire brick.
T. A. S.

Desulphurising Petroleum and Similar Oil.—W. R. Walkley and A. F. Bargate. E.P. 186,738, Oct. 12, 1922.

The oil to be desulphurised is vaporised in the presence of steam and a gaseous dissociating agent, *e.g.*, chlorine or sulphur dioxide, to decompose the hydrogen sulphide formed. The reaction is rendered more effective by passing the gaseous products through a chamber, packed with porous material and surrounded with an electric coil to produce a magnetic field. A convenient chamber can be made out of five feet of 6 in. pipe, round which is coiled three-and-a-half miles of copper wire of 1-32 in. diameter, and carrying a current of 20 ampères. T. A. S.

Petroleum and Petroleum Distillates; Improvements Relating to Treatment of.—A. E. Dunstan and F. B. Thole. E.P. 186,955, May 9, 1921.

Substances of highly-adsorptive surface are prepared by the dehydration of natural or artificial inorganic gels. Many natural hydrated silicates and hydroxides come within this category, but only few possess the necessary surface energy for effective employment. Varieties of fullers' earth such as floridin and bauxite are particularly useful, and suitable artificial gels may be prepared from gelatinous colloidal metallic hydroxides such as iron and aluminium hydroxide. When petroleum distillates are filtered through the dehydrated gels the sulphur compounds are removed by adsorption. The amount of material required for desulphurisation of benzine may be readily determined; 4 lb. of floridin or 9 lb. of bauxite per gallon having been found sufficient in certain cases. T. A. S.

PETROLEUM REFINING; RECOVERY OF BY-PRODUCTS OF.—C. I. Robinson. Assr. to Standard Oil Co. U.S.P. 1,431,259, Oct. 10, 1922. (Appl. Oct. 3, 1919.)

The unsaturated portions of light hydrocarbons produced in the heat treatment of petroleum are recovered by treating the oils with 90% sulphuric acid at about 55–75° F. The resultant sludge is separated and diluted, whereby the oily constituents are separated. The aqueous acid is distilled, the distillate consisting of an oily layer and aqueous alcohols. T. A. S

WAX-SWEATING APPARATUS.—C. S. Dickens, T. E. Schley, and J. W. Newton. Assrs. to Magnolia Petroleum Co. U.S.P. 1,429,721, Sept. 19, 1922. (Appl. Nov. 13, 1920.)

Wax, on an endless belt, is passed through a series of chambers heated to sweating temperature. Each chamber may be heated to any desired temperature. T. A. S.

DEHYDRATOR; CENTRAL CIRCULATING—FOR HYDROCARBON OILS.—W. Meredith. Assr. to Petroleum Rectifying Co. U.S.P. 1,430,245, Sept. 26, 1922. (Appl. March 14, 1921.)

A hollow cylindrical electrode is centrally disposed in a cylindrical container, which is also an electrode. Means are provided to cause emulsion to enter the bottom of the inner electrode and pass outwardly over the top into the space between the electrodes. A potential difference is maintained between the electrodes. T. A. S.

DEHYDRATOR—STRATIFYING—FOR OIL EMULSIONS.—W. Meredith. Assr. to Petroleum Rectifying Co. U.S.P. 1,430,246, Sept. 26, 1922. (Appl. April 30, 1921.)

A charged electrode is supported in and surrounded by the emulsion to be treated. Means are also provided for surrounding the electrode with a fluid envelope of higher di-electric strength than the emulsion to be treated. T. A. S.

ELECTRICAL DEHYDRATORS; STARTED FOR.—F. W. Harris. Assr. to Petroleum Rectifying Co. U.S.P. 1,430,301, Sept. 26, 1922. (Appl. Nov. 1, 1920.

An emulsion is drawn from a bulk supply and passed through an electric field at such a rate that a permanent short circuit in the field is prevented. The coarse emulsion so formed is then submitted to the action of a second electric field, in which the disruption of the current paths occurs automatically without mechanical agitation. T. A. S.

DEHYDRATOR; ADJUSTABLE FIELD.—H. C. Eddy. Assr. to Petroleum RECTIFYING Co. U.S.P. 1,430,295, Sept. 26, 1922. (Appl. June 25, 1921.)

A flat electrode moving in its own plane is suspended in a tank which is also an electrode. T. A. S.

DEHYDRATOR; DOUBLE FIELD.—H. C. Eddy. Assr. to Petroleum Rectifying Co. U.S.P. 1,430,296, Sept. 26, 1922. (Appl. June 25, 1921.)

A hollow electrode is suspended centrally in a tank, which is also an electrode, and has a member projecting centrally into the inner hollow electrode. T. A. S.

DEHYDRATOR—FOR PETROLEUM EMULSIONS.—H. C. Eddy and J. T. WHITTIER. Assrs. to Petroleum Rectifying Co. U.S.P. 1,430,294, Sept. 26, 1922. (Appl. March 2, 1921.)

Emulsions are treated in a tank fitted with a cylindrical electrode, concentric with the tank and means are provided for imparting a rotary movement to the body of emulsion. T. A. S.

DEHYDRATION—METHOD OF AUTOMATIC.—F. W. Harris, Assr. to Petroleum Rectifying Co. U.S.P. 1,430,302, Sept. 26, 1922. (Appl. May 31, 1921.)

The dehydrator consists of a tank fitted with electrodes and a means of closing the oil inlet valve to the tank on failure of the current supply. T. A. S.

HYDROCARBON OILS AND GASES; PROCESS OF RECOVERY AND REFINING OF.—W. J. Knox, Assr. to E. D. Warren. U.S.P. 1,433,956, Oct. 31, 1922. (Appl. May 15, 1919.)

Liquid hydrocarbons are withdrawn from an oil well and heated. The heated hydrocarbon is then returned to the well at a temperature sufficient to volatilise the desired product which is removed from the well in vapour form and condensed. T. A. S.

CONDENSER.—E. W. Liljegran. U.S.P. 1,434,301, Oct. 31, 1922. (Appl. March 5, 1920.)

A horizontal flue is fitted with a series of oblique baffle plates, with intermediate foraminous screens. Liquid is sprayed on the screens, a liquid receiving tank being located beneath the baffles and screens. T. A. S.

OIL TOPPING PLANT.—B. Galsworthy. U.S.P. 1,428,159, Sept. 5, 1922. (Appl. July 14, 1919.)

Hot flue gases are passed through coils arranged in a still. Oil is sprayed on to the upper coils and caused to drip on to the lower ones by means of baffles. The outlet for unvaporised oil is arranged so that the bottom coil is continually immersed. T. A. S.

EMULSIONS OF PETROLEUM; APPARATUS FOR TREATING.—W. S. Barnickel. U.S.P. 1,428,204, Sept. 5, 1922. (Appl. Aug. 5, 1922.)

The emulsion and a treating fluid are pumped together through a steam-heated conduit to a settling tank. The mixture is agitated during its passage through the conduit. T. A. S.

DEHYDRATOR.—W. Meredith, Assr. to Petroleum Rectifying Co. U.S.P. 1,428,178, Sept. 5, 1922. (Appl. Oct. 28, 1920.)

An emulsion is treated in a vessel divided by dielectric diaphragms, through which an electrode passes. The electrode is insulated in its upper portion by an ordinary insulator, and also by dehydrated oil. The emulsion is dehydrated by a high potential discharge between the lower portions of the electrode and the walls of the vessel. T. A. S.

LUBRICATING OILS.

LUBRICATING OILS, BEARING FRICTION AND FRICTION EXPERIMENTS.—Duffing. *Z. angew. Chem.*, 1922, **35**, 605-607.

A lubricant has to satisfy two conditions: It must withstand the pressure exerted by the bearing on the journal, and also the deformation

of its ultimate particles must meet with the minimum resistance. The first of these conditions demands a high viscosity, and the second a low viscosity. In a lubricant in flowing motion a certain force K is required to produce this deformation, and $K=\mu\frac{d\,v}{d\,n}$, when K = force per unit of surface in dynes/cm.$^{-2}$, V = velocity in cm/sec., *dn*, the distance between the nearest layers, and μ, units of absolute viscosity. In cases of laminar flow the following formulæ accord with the results of practice: $\delta p/\delta x=\mu\Delta u$. $\delta p/\delta y=\mu\Delta v$. $N\delta u/\delta x+\delta v/\delta y=0$. In these formulæ $\Delta=\delta^2/\delta x^2+\delta^2/\delta y^2$, is equivalent to Laplace's operator. These formulæ may be made easier to deal with by the introduction of the function of flow ψ, but still present difficulties caused by the edge conditions. It has been supposed that the lubricant is between two flat surfaces, under constant pressure, and that the surfaces move with a constant velocity. The conditions are much more varied in the case of a bearing, in which the viscosity μ can be calculated from the moment of friction by the formula $M_T=4\pi\mu\dot{\omega}\ R_1^2\ R_2^2/R_1^2-R_2^2$. The case is, however, quite different if the journal lies excentric to the bearing. This produces a great increase in pressure, which may reach 60–70 atm. A machine has been constructed for the study of friction under such conditions. In this machine the bearing is suspended in a stirrup, and means are provided for bringing any desired pressure to bear on it. The velocity may be 3,000 to 16,000 revolutions per minute. A record is produced by the deformation of a measuring spring, which traces a curve on a moving diagram. The movement of the bearing is produced by an electric motor, and the velocity measured by a vortex current tachometer. The pressure may be raised to 8,000 kilogr.

H. M.

PURIFYING APPARATUS FOR LUBRICATING OILS.—E. E. Hans. U.S.P. 1,420,837. June 27, 1922.

The apparatus is designed for use with internal-combustion engines. The volatile diluents of the lubricating oil are distilled off.

T. A. S.

OILY PASTES OR EMULSIONS FROM MINERAL OR OTHER OILS.—H. Plauson. E.P. 185,779. Sept. 6, 1922. Appl., Apl. 6, 1921.

Emulsions of oil and water are prepared with the aid of a colloid mill (E.P. 155,836 Plauson & Veille). These emulsions are of pasty nature and can be used in the same way as Stauffer fat. The water content can be increased to 4 to 8 times that of the oil if from 1 to 3 per cent. of a finely powdered solid *e.g.*, magnesium or barium carbonate or oxide. Graphite or talc or other solid lubricants can be incorporated. If it is desired to incorporate a large amount of water suitable protective colloids or agents as paraffin wax, glycerine or similar materials can be used for making boring pastes and soap like lubricants. The advantage of the system consists in the fact that all the materials used are neutral.

T. A. S.

HYDROCARBON OILS AND OTHER OILS AND FATS; PROCESS OF INCREASING THE CONSISTENCY.—H. M. Frentrup and P. Kiederich. E.P. 185,782. Sept. 12, 1922. Appl., Apl. 12, 1921.

A salve like mass is made from pale spindle oil by adding to it castor oil and fish oil, which have been partially split by means of sulpho-aromatic acid. The splitting of the vegetable and animal oil must not be carried beyond 50%. A salve melting at 72° C. is made by adding 100 kg. of pale spindle oil (sp. gr. ·890–·910) to 5·75 kg. of castor

oil which has been partially split by Twitchell reagent and to which 1·75 kg. of fish oil has been added. To the mixture 8 kg. of caustic lye (40%) is added and the mass stirred with a spatula.

T. A. S.

THE SELECTION OF LUBRICATING MATERIALS. By I. LOOTCHINSKY. (*The Journal of the Groeni Petroleum Industry, No.* 4, *July*, 1922, *p.* 34-39.)

Professor Lootchinsky states that in the selection of lubricating oils, apart from the determination of its viscoaity, it is necessary to take into consideration the interior friction of the oil itself. Viscosity phenomena are largely functions of the frictional surface of ions, molecules, and molecular aggregation in any given solution. Therefore, to arrive at the proper value of the quality of a lubricant it is necessary to use the following formula :—

$$F = \frac{N R^4 D}{8 DL} . C^{11}$$

F. = Absolute interior friction.

N. = 3·14.

D. = Pressure in grams on a square centimetre.

R. = Radius of the capillary tube in centimetres.

L. = Length of the capillary tube in centimetres.

C^{11} = The time in seconds in which the flow of the liquid takes place.

In order to measure the radius of the capillary tube it is necessary to have a graduating machine and the exact measure of length ; but in an ordinary laboratory this could not be done, therefore the method of comparison of the time of the flow of oil and water is accepted. The viscometers usually adopted are Engler's, Redwood's, Lemansky, Ubelhode, and others. But in all of them no exact relation of the length to the diameter of the capillary tube is given. The author claims that the viscometer designed by him is based on the formula given above. The capillary tube is a straight one, and is constructed in such a manner that the relation of its radius to its length is not less than 400.

The author claims that with his viscometer he can estimate the inner friction of any oil at any temperature. The chief indication of lubricating materials should be the value of its interior friction, but not the flash point sp. gravity, or the contents of asphalt bodies. The Petroleum trade must try to dispel the idea of the consumers that the lubricants have to be of a special colour. After all, at present, petroleum lubricating oils have now to compete with very good lubricating oils produced from coal tar. As an example, the author shows that on the Russian railways lubricating oils are now used without preliminary treatment by acid or soda, and the presence of asphalt bodies does not affect their lubricating qualities.

P. D.

OIL AND SHALE.

THE OIL SHALE OF KENTUCKY.—V. C. Alderson. *Quarterly of the Colorado School of Mines*, 1922, **17**, No. 4, page 15.

The shale is mostly composed of the remains of sea animals, having been deposited in what is known as the Devonian sea, and by subsequent uplift and erosion is now found outcropping around the edges of the Cincinatti anticline.

The shale strata has an average thickness of 50 feet, and the dip is so slight that it can be easily worked to three miles back from the

outcrop by open cut and steam shovel methods. At an average of 130 lbs. per cub. ft. the amount of shale available is calculated to be 90,604,800,000 tons. The oil content varies from 8 to 30 gallons per ton of shale, but it is expected that an overall average of 21 gallons can be obtained. The oil is of about 0.95 sp. gr., gives 12 to 20% of gasoline, 20 to 30% of kerosene and 30% of lubricating oils, whilst theoretically 97 lbs. of sulphate of ammonia per ton of shale are present. As the shale resembles that of Scotland a modified Scotch retort has been found suitable, the modifications consisting of a device for drying and preheating the shale before entering the retort and a steeper slope to the walls, so that a greater rate and larger throughput is possible. It is estimated that the Kentucky shales alone are capable of producing at least four times the amount of recoverable oil at present remaining in the oil fields of the United States. For commercial purposes gasoline, fuel oil and ammonium sulphate are at present the only three products worth considering, and any attempts to completely refine the oil will be a commercial failure. A short account is given of oil shales in Russia, where attempts have lately been made to develop the industry.

F. G. P. R.

A New Process for the Winning and Upgrading of Peat.—J. Steinert. *Z. angew. Chemie*, 1922, **35**, 553–555.

The high costs of carriage are particularly sensible in the case of fuels of low value such as lignite and peat, the calorific value of peat being 3,500 calories and for raw lignite 2,500 calories, against 7,000 calories for coal, for the same unit of weight and transport charges, and the comparison is still more unfavourable if bulk is taken into consideration. Peat, in addition to some 5% of ash, contains 25–30% of loose water, 15% of water of composition, 1–2% of nitrogen, 30–35% of fixed carbon and 10–15% of hydrocarbons. The upgrading of peat may be carried out by coking or by briquetting. For briquetting the water content is reduced to 12–15%; the volume is reduced to one-half, and the calorific value is increased 25–30%; 1 cub. metre of peat briquettes contains 45 million calories, in place of 21 million calories for raw peat. By coking, the whole of the water may be withdrawn together with part of the nitrogen. The hydrocarbons are driven off, part as gases, but mostly in the tar. The commercial success of peat briquetting systems depends upon the economic drying of the peat. Peat dried by exposure to the open air does not attain a less water content than 25%, at which point an equilibrium is attained in the drying process. The colloidal water in peat is in a similar state to water of crystallisation, and the peat also shows a tendency to dry on the outer surface, while the inside remains wet. Experiments on the drying of peat were made in a drum 10 mm. long and 2½ mm. in diameter, by means of direct contact with flue gases. An improvement was made by the adoption of a cellular construction of the walls of the drum, by which means the production of fine dust was avoided. The water vapour in the gases was superheated by the combustion gases and acted directly upon the peat, and it was found possible to evaporate 1 kgr. water with 1060 calories expenditure of heat. The peat could be briquetted by a pressure of 250–400 atm. All care was taken to recover heat from the issuing gases, etc. Coking of peat was also attempted in a shaft retort and 10–13% of tar was recovered, having a composition of 15% of paraffin wax, 15% of viscous oils, 12% of non-viscous oils and 41% of phenols. The distillation of the peat could not be commenced before the end of drying, as otherwise

a tar was obtained of the same sp. gr. as water and which easily emulsified. The hot coke is cooled by means of cold gases, and thus its heat recovered. A yield of 9–10% of tar was obtained. H. M.

OIL SHALES; METHOD FOR DISTILLING.—P. Danckwardt. A.P. 1,432,101. Oct. 17, 1922. Appl. March 8, 1920.

Highly heated waste shale and raw shale are continuously fed into a still. The heat derived from the waste shale distils off the volatile matter from the raw shale.

T. A. S.

OILS AND PITCH, PROCESS OF OBTAINING FROM SHALES, COAL, WOOD, ETC.—W. C. Wells and F. E. Wells. A.P. 1,433,051. Oct. 24, 1922. Appl. Aug. 30, 1921.

The shale or other material is continuously fed into an annular retort, both surfaces of which are heated. A neutral heated gas is passed into the bottom of the retort and carries away the vapours.

T. A. S.

ENGLAND'S OIL SHALES; SIGNIFICANCE OF.—H. E. Akroyd. *Petroleum Times*, 1922, **7**, 576.

Scientific investigation in the shale industry has been hindered by the greater profits obtainable in the oil industry. Scottish shale has been almost entirely treated for NH_3 and paraffin which should be by-products. The internally heated retort is replacing the externally heated retort, superheated steam at not more than 400° C. being used for the distillation. A higher yield of NH_3 is obtained. The highly unsaturated product is easily converted into 90% saturated products and its high aromatic content enhances its value as a motor fuel.

T. A. S.

OIL SHALES OF ESTHONIA.—E. H. Cunningham-Craig. *Petroleum Times*, 1922, **7**, 673, 697.

The yield of oil per ton from this shale is very high, being theoretically over 90 gals. per ton. The mineral matter has the composition of fullers earth and limestone. Distillation is very rapid and complete below 450° C., but does not begin at low temperatures. The distillation in vertical retorts is not believed to be practicable. The deposits are estimated to consist of 1,000 million tons, which would yield from 70 to 80 gallons per ton of oil of sp. gr. ·92 to ·93, capable of being easily refined, containing little sulphur and wax being almost entirely absent.

T. A. S.

HYDROCARBONS FROM SHALE OIL; PROCESS AND APPARATUS FOR RECOVERY OF.—C. W. Thompson. U.S.P. 1,428,458. Sept. 5, 1922. Appl. Sept. 15, 1919.

The shale is heated by external means to remove gasolene and light oils, which are taken off separately. It is then further heated to vaporise the heavy hydrocarbons, the vapours being used to preheat cold shale prior to the first heat treatment.

T. A. S.

INDEX.

Abstracts, 102-144, 260-268, 431-464, 537-576, 714-741.
Analyses of Seepages, significance of interpretation of, 193-213
Anfilogoff, N. A., on Better Production Methods, 59
Anfilogoff, N. A., on Standardisation, 604-606
Annual Dinner, Fourth, 276-291
Annual General Meeting, Ninth, 292-300
Annual Report of Council, 1921, 269-275
Ashmead-Bartlett, P. A., on Better Production Methods, 56
Ashworth, A., on Oilfield Waste, 42-44
Asphalt Industry, Colloidal State of Matter in its Relation to, 79-82

Bailey, E. M., Shale Oil Industry of Scotland, 465-490
Banks, B. G. See Craven, E. C.
Barringer, H., on Better Production Methods, 55-56
Benzene, Solubility in Weak Alcohol, 213-217
Bibliography, 83-101, 230-259, 401-430, 505-536, 690-714
Bibliography, Polish and German, of Galician Petroleum Industry, 666-687
Black, Sir F. W., on Standardisation, 611-613
Blackler, M. B., on Standardisation, 611
Brame, J. S. S., on Oilfield Waste, 32-34
Brame, J. S. S., on Better Production Methods, 63
Brame, J. S. S., on Flash-point Temperatures, 173-174
Brame, J. S. S., on Analyses of Seepages, 206
Brame, J. S. S., Presidental Address, 300-311
Brame, J. S. S., on Esthonian Oilshale, 359-361
Brame, J. S. S., on Standardisation, 601-602
Brame, J. S. S., on Pole Tool Drilling, 655
Calder, W., on Pole Tool Drilling, 657-658
Chemical Analyses of Seepages, 193-213
Chemistry, Colloid, of Petroleum, 73-79
Colloid Chemistry of Petroleum, 73-79
Colloidal State of Matter in its Relation to the Asphalt Industry, 79-82
Craig, E. H. C., Kukkersite, the Oilshale of Esthonia, 349-375, 498-499
Craig, E. H. C., on Standardisation, 610
Craven, E. C., on Standardisation, 615-616
Craven, E. C. See Ormandy, W. R.
Craven, E. C., and B. G. Banks, Effect of Small Quantities of Volatile Impurities on the Flash-point of Kerosene, 490-498

Dabell, A. F., on Oilfield Waste, 37-39
Dabell, A. F., on Better Production Methods, 50-66
Dabell, A. F., on Pole Tool Drilling, 655-657
Dabell, C., on Galician Industry, 342
Dabell, C., on Pole Tool Drilling, 660-661, 664
Drilling, Galician-Canadian Pole Tool System, 617-665
Duckham, A., on Standardisation, 602-603
Dunstan, A. E., Colloid Chemistry of Petroleum, 73-79
Dunstan, A. E., on Standardisation of the Testing of Petroleum and its Products, 578-617

Esthonia, Oilshale of, 349-375, 498-499
Ethyl Alcohol-Water-Paraffins from + 30° C. to –30° C., 181-193
Evans, E. A., on Better Production Methods, 62-63
Evans, E. A., on Flash-point Temperatures, 177-178
Evans, E. A., on Galician Industry, 343
Evans, E. A., on Esthonian Oilshale, 366-367

Flash-point of Kerosene, Effect of Volatile Impurities on, 490-498
Flash-point Temperatures, Physico-Chemical Significance of, 145-180
Fuels, Hydrocarbon, Determination of Vapour Pressure and Estimation of Dissolved Air, 217-223

Galicia and its Petroleum Industry, 312-348
Galician Petroleum Industry, Polish and German Bibliography, 666-687
Galician-Canadian System of Pole Tool Drilling, 617-665
Gressler, A. F., on Standardisation, 613

Hackford, J. E., Significance of the Interpretation of the Chemical Analyses of Seepages, 193-213
Halse, G. W., on Galician Industry, 342
Heaton, F. A., on Pole Tool Drilling, 658
Henderson, J. A. L., on Analyses of Seepages, 210-211
Henderson, J. A. L., on Galician Industry, 342-343
Henderson, W. H., on Pole Tool Drilling, 658-660
Hobden, H., on Oilfield Waste, 34-35
Holland, Sir T. H., on Analyses of Seepages, 206-209
Holland, Sir T. H., on Galician Industry, 340-341, 343-344
Hookham, F. J., on Pole Tool Drilling, 664
Howell, G., on Esthonian Oilshale, 367-368
Hutchins, S., on Esthonian Oilshale, 364

Ibbett, A. W., on Oilfield Waste, 44-45
Ibbett, A. W., on Better Production Methods, 57-59, 61
Insulating Oils, Colour and Sludging Characteristics, 67-72
Ivey, W., on Oilfield Waste, 36-37

Kerosene, Flash-point of, Effect of Volatile Impurities on, 490-498
Kewley, J., on Oilfield Waste, 45-46
Kewley, J., on Better Production Methods, 59-60
Kukkersite, the Oilshale of Esthonia 349-375, 498-499

Le Maistre, C., on Standardisation, 603-604
Lessing, R., on Flash-point Temperatures, 176-177
Lessing, R., on Analyses of Seepages, 209-210

MacDougall, A., on Standardisation, 615
McKeever, C. B., on Pole Tool Drilling, 660, 661-662
McMullen, W., on Oilfield Waste, 46-47
McQueen, J. F., on Better Production Methods, 57
Macrorie, B. F. N., on Shafts and Galleries, 396-398
Madgwick, T. G., on Oilfield Waste, 35-36
Madgwick, T. G., on Galician Industry, 342
Madgwick, T. G., on Esthonian Oilshale, 372-374
Marshall, A. G. See Tizard, H. T.
May, H., on Oilfield Waste, 41
May, H., on Better Production Methods, 65
Millar, A., on Oilfield Waste, 39-41
Millar, A., Galicia and its Petroleum Industry, 312-348
Millar, A., Galician-Canadian System of Pole Tool Drilling, 617-665
Moore, H., on Flash-point Temperatures, 175-176

Neilson, H., on Esthonian Oilshale, 365

Oilfield Waste, Elimination of, 1-49
Ormandy, W. R., on Better Production Methods, 55, 63
Ormandy, W. R., on Analyses of Seepages, 211
Ormandy, W. R., and E. C. Craven, Investigation into the Physico-Chemical Significance of Flash-point Temperatures, 145-180
Ormandy, W. R., and E. C. Craven, The Systems Ethyl Alcohol-Water-Paraffins, from + 30° C. to -30° C., 181-193

ORMANDY, W. R., and E. C. CRAVEN, Note on Solubility of Benzene in Weak Alcohol, 213-217

PARISH, W. F., When Oil is "Good," 224-229
PENNEY, F. M., on Better Production Methods, 60-61
PENNEY, F. M., on Pole Tool Drilling, 661
PERKIN, F. M., on Esthonian Oilshale, 362-364, 367
Petrols for Road Vehicles and Aircraft, 376-396
PHILIP, A., on Standardisation, 606-609
PITT, G., on Better Production Methods, 61-62, 63
PITT, G., on Analyses of Seepages, 211
PITT, G., on Esthonian Oilshale, 365-366
PITT, G., on Standardisation, 609-610
Pole Tool Drilling, Galician-Canadian System, 617-665
Presidential Address, 300-311
Production Methods, Better, 50-66

Rappoport, F. G., on Galician Industry, 343
REDGROVE, E. R., on Analyses of Seepages, 211
REUSS, P., on Esthonian Oilshale, 365
Reviews:
"The Chemistry of the Non-Benzenoid Hydrocarbons," B. T. Brooks, 504
"Distillation Principles and Processes," S. Young, 399-400
"Economics of Petroleum," J. E. Pogue, 500-501
"Gas Chemists Handbook," American Gas Association, 501-502
"Geology of the Tertiary and Quaternary Periods in the North-West Part of Peru," T. O. Bosworth, 688-689
"Handbook of the Petroleum Industry," D. T. Day, 502-504
"Oil Encyclopedia," M. Mitzakis, 400
Reviews—*Continued*:
"Oil Flow in Pipe-Lines," R. S. Danforth, 500
"Petroleum and Allied Industries," J. Kewley, 504
"A Treatise on Petroleum," Sir B Redwood, 399
RICHARDSON, C., Colloidal State of Matter in its Relation to the Asphalt Industry, 79-82
ROMANES, J., on Esthonian Oilshale, 374-375

Scotland, Shale Oil Industry of, 465-490
Seepages, Chemical Analyses of, 193-213
Shale Oil Industry of Scotland, 465-490
Standardisation of Testing of Petroleum, 578-617
Systems Ethyl Alcohol - Water - Paraffins, 181-193

Testing Petroleum, Standardisation of, 578-617
THOLE, F. B., on Flash-point Temperatures, 177
THOMPSON, A. B., Elimination of Oilfield Waste, 1-49
THOMPSON, A. B., on Esthonian Oilshale, 371-372
THORNYCROFT, O., Petrols for Road Vehicles and Aircraft, 376-396
TIZARD, H. T., and A. G. MARSHALL, Method for the Determination of Vapour Pressure of Hydrocarbon Fuels and the Estimation of Dissolved Air, 217-223

Vapour Pressure of Hydrocarbon Fuels, Determination of, 217-223

WADE, A., on Better Production Methods, 56, 57
WARD, R. S., on Better Production Methods, 65-66
WATTS, W. W., on Esthonian Oilshale, 361-362
WEDMORE, E. B., Insulating Oils—Colour and Sludging Characteristics, 67-72

Willcox's

SEMI-ROTARY OIL PUMPS

For Tank Cars, Road Wagons, Storages, and general pumping of Oil, Petroleum, and Motor Spirit. Powerful in lifting and forcing. Clearway through valves. All sizes up to 4ins. connections.

4000 in Stock.

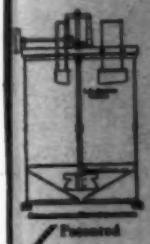
"Jones-Willcox" Patent

WIRE-BOUND OIL HOSE

For suction and delivery of Oil, Petroleum, Motor Spirit, etc. Specially suitable for importing and distributing Companies, and used largely for discharging Tank Ships, etc., and in Storage and Service Depots.

Write for Lists.

W. H. WILLCOX & Co., Ltd., 32-38 Southwark Street, LONDON, S.E.1.



Patented

TYPHOON AGITATORS

Regd.

For Washing Petroleum, Petrol, Benzol, Edible Oils, etc., and mixing all forms of Fluid and Semi-Fluid, used by the largest Petroleum and Benzol Refineries in the world.

THEY SAVE ACID, TIME & POWER.

TYPHOON AGITATORS TURN OUT A BETTER PRODUCT AT A LOWER COST

Send for particulars to

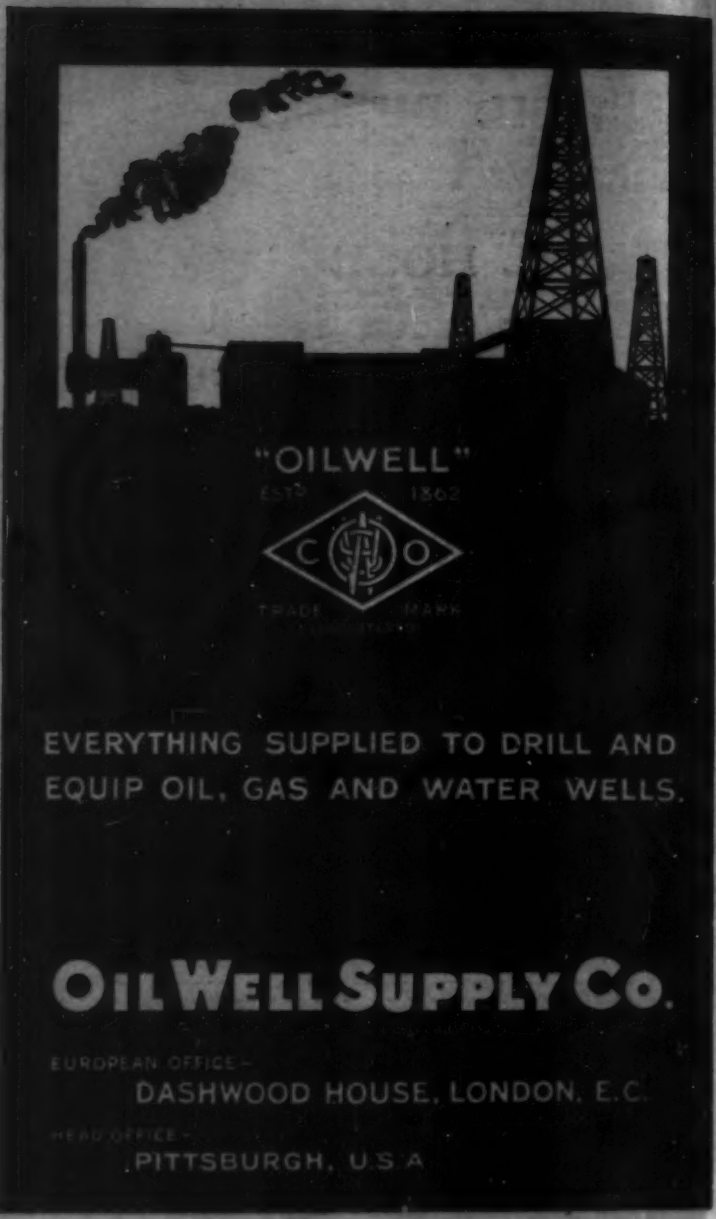
W. CHRISTIE & GREY LTD

4 LLOYDS AVENUE

LONDON, E.C. 3.

Telegrams: Typhoogher Fen, London.

Telephone: Avenue 8252



EVERYTHING SUPPLIED TO DRILL AND EQUIP OIL, GAS AND WATER WELLS.

OIL WELL SUPPLY CO.

EUROPEAN OFFICE—
DASHWOOD HOUSE, LONDON, E.C.

HEAD OFFICE—
PITTSBURGH, U.S.A.